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# SR 77 CORRIDOR PROFILE STUDY

**HOLBROOK TO SHOW LOW**

ADOT WORK TASK NO. MPD-0040-17  
ADOT CONTRACT NO. 18-177972

**DRAFT REPORT: PERFORMANCE AND NEEDS EVALUATION**

*AUGUST 2017*

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PREPARED FOR:

ARIZONA DEPARTMENT OF TRANSPORTATION



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PREPARED BY:



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# ACRONYMS & ABBREVIATIONS

AADT	Average Annual Daily Traffic
ABISS	Arizona Bridge Information and Storage System
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
ASLD	Arizona State Land Department
AZTDM	Arizona Statewide Travel Demand Model
BLM	Bureau of Land Management
BQAZ	Building a Quality Arizona
CCTV	Closed Circuit Television
CR	Cracking Rating
DCR	Design Concept Report
DMS	Dynamic Message Sign
FHWA	Federal Highway Administration
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HERE	Real time traffic conditions database produced by American Digital Cartography Inc.
HPMS	Highway Performance Monitoring System
I-	Interstate
IRI	International Roughness Index
ITS	Intelligent Transportation System
LCCA	Life-Cycle Cost Analysis
LOS	Level of Service
LRTP	Long-Range Transportation Plan
MAP-21	Moving Ahead for Progress in the 21 <sup>st</sup> Century
MP	Milepost
MPD	Multimodal Planning Division
NACOG	Northern Arizona Council of Governments
NB	Northbound

NPV	Net Present Value
OP	Overpass
P2P	Planning-to-Programming
PA	Project Assessment
PARA	Planning Assistance for Rural Areas
PDI	Pavement Distress Index
PES	Performance Effectiveness Score
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
RTP	Regional Transportation Plan
RWIS	Road Weather Information System
SATS	Small Area Transportation Study
SB	Southbound
SERI	Species of Economic and Recreational Importance
SHSP	Strategic Highway Safety Plan
SOV	Single Occupancy Vehicle
SR	State Route
TAC	Technical Advisory Committee
TI	Traffic Interchange
TIP	Transportation Improvement Plan
TPTI	Truck Planning Time Index
TTI	Travel Time Index
TTTI	Truck Travel Time Index
UP	Underpass
USDOT	United States Department of Transportation
V/C	Volume-to-Capacity Ratio
VMT	Vehicle-Miles Travelled
WIM	Weigh-in-Motion



## 1.0 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 77 (SR 77) between Junction Interstate 40 (I-40) and Show Low. The study examines key performance measures relative to the SR 77 corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT has completed eleven CPS as part of three separate groupings or rounds.

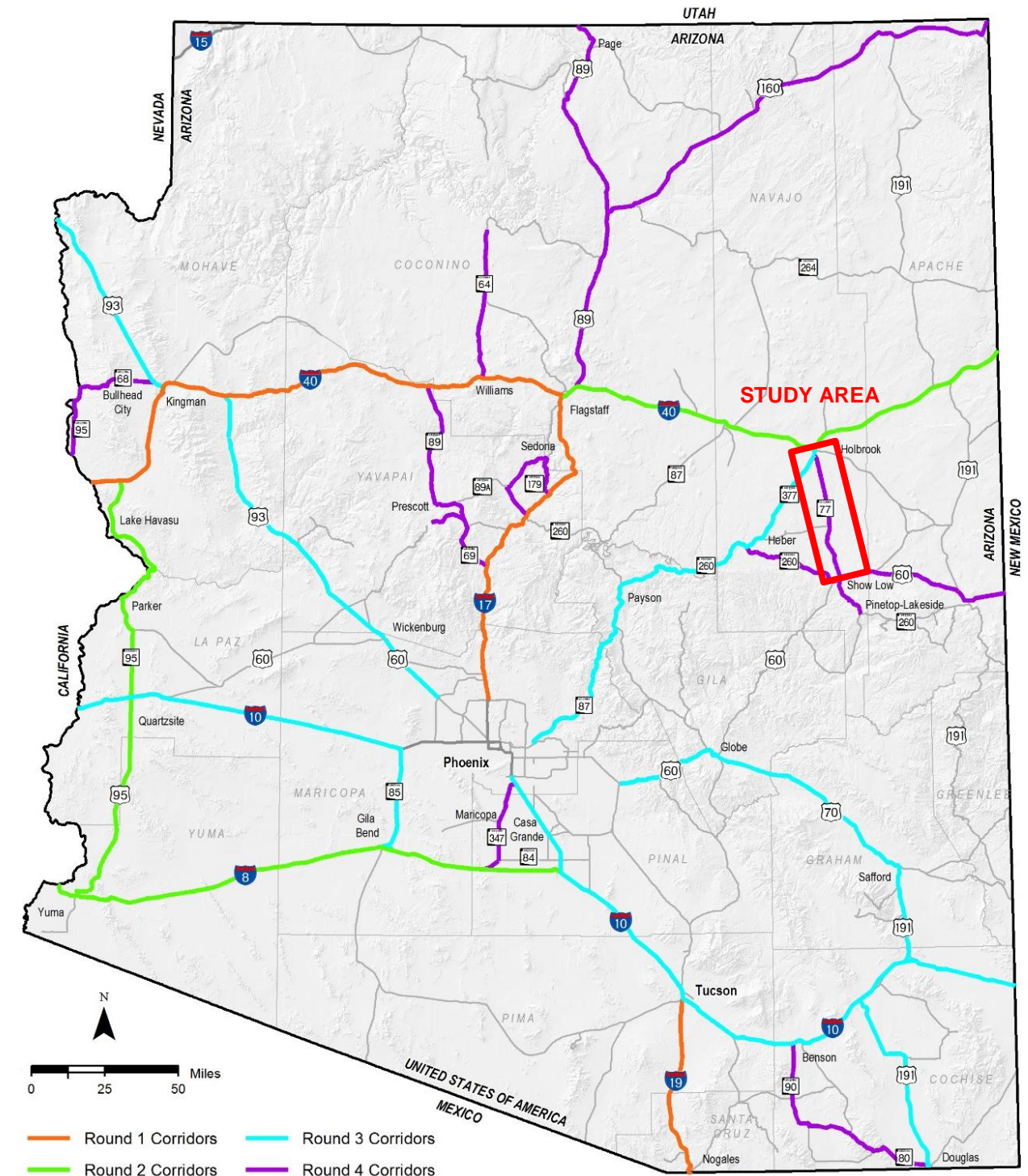
The fourth round (Round 4) of studies began in Spring 2017, and include:

- US 89: I-40 to Utah Stateline
- US 160: US 89 to New Mexico Stateline
- SR 64: I-40 to Grand Canyon National Park
- SR 68: SR 95 to US 93 and SR 95: California Stateline to Nevada Stateline
- SR 69: I-17 to SR 89; Fain Rd: SR 69 to SR 89A; SR 89A: Fain Rd to SR 89;
- SR 89: SR 89A to I-40
- SR 77: US 60 to SR 377
- SR 90: I-10 to SR 80 and SR 80: SR 90 to US 191
- SR 179: I-17 to SR 89A; SR 89A: SR 179 to SR 260; and SR 260: SR 89A to I-17
- SR 260: SR 277 to SR 73 and US 60: SR 260 to New Mexico Stateline
- SR 347: I-10 to SR 84 and SR 84: SR 347 to I-8

The studies under this program assess the overall health, or performance, of the state's strategic highways. The CPS will identify candidate solutions for consideration in the Multimodal Planning Division's (MPD) P2P project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

The SR 77 corridor, depicted in **Figure 1**, is one of the strategic statewide corridors identified and the subject of this Round 4 CPS.

Figure 1: Corridor Study Area



## 1.1 Corridor Study Purpose

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

## 1.2 Study Goals and Objectives

The objective of this study is to identify a recommended set of prioritized potential improvements for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The SR 77 CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance. Corridor benefits can be categorized by the following three investment types:

- **Preservation:** Activities that protect transportation infrastructure by sustaining asset condition or extending asset service life
- **Modernization:** Highway improvements that upgrade efficiency, functionality, and safety without adding capacity
- **Expansion:** Improvements that add transportation capacity through the addition of new facilities and/or services

This study identifies potential actions to improve the performance of the SR 77 corridor. Proposed actions are compared based on their likelihood of achieving desired performance levels, life-cycle costs, cost-effectiveness, and risk analysis to produce a prioritized list of solutions that help achieve corridor goals.

The following goals are identified as the desired outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

## 1.3 Corridor Overview and Location

SR 77 serves as a key link within the White Mountain area and Mogollon Rim area connecting Holbrook to Show Low. The easterly portion of Arizona is, generally, a popular destination for residents looking for snow in the winter and seeking relief from high temperatures in the summer. While SR 77 is not as significant a connection for visitor traffic as other roads in the region, it provides the most efficient link to Holbrook, the Navajo County seat and I-40 from Show Low and the east-central portion of the state.

SR 77 from Show Low (US 60) to Holbrook was initially constructed in the late 1930s and early 1940s. Much of the segment between Show Low and Snowflake has been upgraded by realignment in the 1970s and 1980s, with passing lanes added occasionally in both directions. Between Snowflake and Holbrook some passing lanes have been added, culverts extended and slopes flattened, but most of the roadway remains as constructed in the 1940s, a 28-foot roadway.

The higher forested elevations in Show Low give way to relatively flat, open land between Taylor and Holbrook. The roadway narrows to two lanes north of Show Low and remains that way, except in urban segments such as the Town of Snowflake, all the way to the outskirts of Holbrook just south of I-40.

## 1.4 Corridor Segments

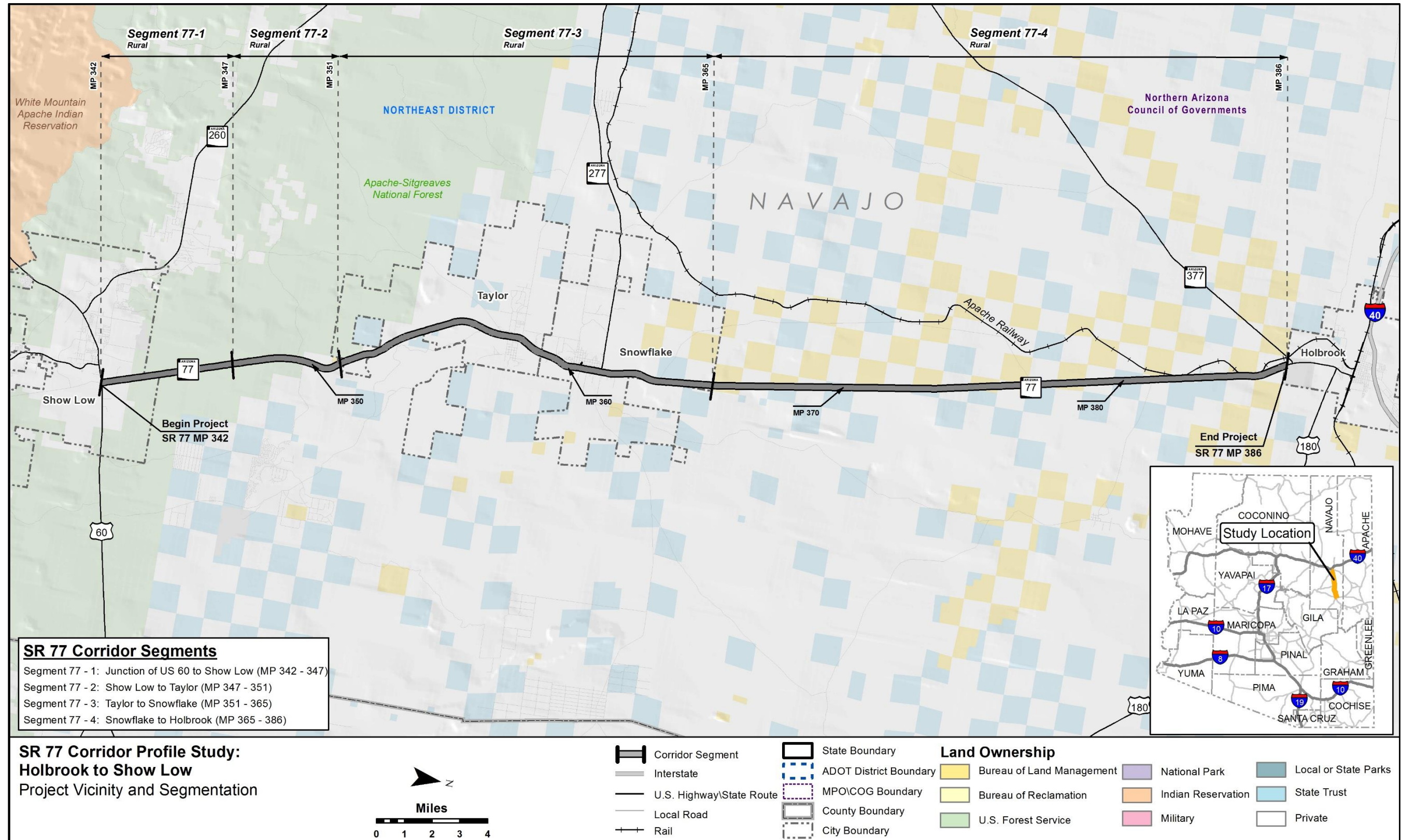
The SR 77 corridor is divided into five planning segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are described in **Table 1** and shown in **Figure 2**.

**Table 1: SR 77 Corridor Segments**

Segment #	Route	Begin	End	Approx. Begin Milepost	Approx. End Milepost	Approx. Length (miles)	Typical Through Lanes (NB/EB, SB/WB)	2015/2035 Average Annual Daily Traffic Volume (vpd)	Character Description
77-1	SR 77	Junction of US 60	Show Low	342	347	5	1,1	9,000 / 13,000	The rural two-lane roadway is relatively flat and has consistent traffic volumes as it leaves Show Low.
77-2	SR 77	Show Low	Taylor	347	351	4	2,2	8,000 / 12,000	Segment 77-2 is mostly a four-lane undivided road with uninterrupted flow that contains both flat and rolling terrain.
77-3	SR 77	Taylor	Snowflake	351	365	14	2,2	14,000 / 20,000	A five-lane undivided roadway with interrupted flow passes through the towns of Taylor and Snowflake.
77-4	SR 77	Snowflake	Holbrook	365	385	20	1,1	4,000 / 8,000	This rural two-lane segment with uninterrupted flow has flatter terrain than other segments in the corridor.



Figure 2: Corridor Location and Segments



## 1.5 Corridor Characteristics

The SR 77 corridor is an important travel corridor in the northeastern part of the state. The corridor functions as a route for recreational, tourist, and regional traffic and provides critical connections between the communities it serves and the rest of the regional and interstate network.

### National Context

The SR 77 corridor is a strategic transportation link across northeastern Arizona for freight and intercity travel. The SR 77 corridor also functions as an alternate route to I-17/I-10 when either of those facilities is closed due to adverse weather or incidents.

### Regional Connectivity

The SR 77 corridor between Holbrook and Show Low provides movement for freight, tourism, and recreation needs within Arizona. The corridor is in the Northeast ADOT District; the Northern Arizona Council of Governments (NACOG) planning area; and Navajo County. Within the corridor study limits, SR 77 offers connections to several major roadways, including US 60, US 180, SR 377, SR 260, SR 277, and I-40. This corridor serves Arizona cities and towns including Holbrook, Snowflake, Taylor, and Show Low.

### Commercial Truck Traffic

Communities along the SR 77 corridor are dependent on the corridor to access the state economy through freight deliveries and travel to other locations. Freight traffic (trucks) comprise from 8.7% to 18.6% of the total traffic flow on the corridor, with the higher truck percentages between Snowflake and just south of Holbrook.

### Commuter Traffic

Most of the commuter traffic along the SR 77 corridor occurs within the urbanized areas of Snowflake, Taylor, Holbrook, and Show Low. These areas are economic centers along what is considered mostly a rural combination of state routes and local roads. According to the most recent traffic volume data maintained by ADOT, traffic volumes range from approximately 4,400 vehicles per day on SR 77 between SR 277 and-SR 377 to approximately 13,600 vehicles per day within the urban areas of Taylor and Snowflake.

According to the 2015 American Community Survey data from the US Census Bureau, 89.9% of the workforce in areas along the corridor relies on a private vehicle to get to work.

### Recreation and Tourism

SR 77 provides access to the Apache-Sitgreaves National Forest, and Holbrook Petrified Forest National Park (via I-40 near Holbrook).

## Multimodal Uses

### Freight Rail

The BNSF Railway, one of the top transporters of intermodal freight in North America, crosses through the City of Holbrook. The BNSF "Transcon Corridor" connects Los Angeles with Chicago and passes through northern Arizona, paralleling I-40. The BNSF Transcon Corridor typically carries up to about 120 trains per day. The BNSF Railway currently interchanges with a short line railroad, the Apache Railway, in Holbrook. The Apache Railway runs northward from Snowflake terminating in Holbrook and is primarily used for paper and mining products<sup>1</sup>.

### Passenger Rail

Amtrak's Southwest Chief Chicago to Los Angeles route primarily serves long-distance tourist travel, with daily service. The Southwest Chief shares track on the BNSF Transcon Corridor and is subject to delays caused by freight traffic. It travels at an average speed of 63 miles per hour across the State. There is no passenger station in Holbrook. The nearest passenger stations are in Winslow, Arizona and Gallup, New Mexico. There is no passenger rail service between the City of Show Low and the City of Holbrook.

### Bicycles/Pedestrians

Opportunities for bicycle and pedestrian travel are limited on SR 77. Bicycle traffic is permitted on the mainline outside shoulder; however, outside shoulder widths are less than the preferred 4-foot minimum width between Snowflake and Holbrook, and along two sections of the corridor south of Snowflake.

### Bus/Transit

The White Mountain Connection offers bus service from Holbrook to smaller communities south such as Snowflake, Taylor, Show Low, and Pinetop-Lakeside, along with stops at the Navajo County Government offices and Northland Pioneer College campuses.

### Aviation

The Show Low Regional Airport, which owned and operated by the City of Show Low, is the only commercial aviation facility in proximity to the SR 77 corridor. There are also two nearby general aviation facilities. These include the Holbrook Municipal Airport, owned and operated by the City of Holbrook, the Taylor Municipal Airport-Tyl, owned and operated by the Town of Taylor.

### Land Ownership, Land Uses and Jurisdictions

As shown previously in **Figure 2**, the SR 77 corridor traverses multiple jurisdictions and land owned or managed by various entities in Navajo County. The southern half of the corridor traverses mix of private land and Forest Service land. The northern half traverses a mix of private land, State Trust Land, and Bureau of Land Management (BLM) land.

<sup>1</sup> Source: Arizona State Rail Plan (2011), Appendix A



### Population Centers

Population centers of various sizes exist along the SR 77 corridor. **Table 2** provides a summary of the populations for communities along the corridor. Moderate population growth is projected between 2010 and 2040 in the major population centers along the corridor according to the Arizona State Demographer's Office.

**Table 2: Current and Future Population**

Community	2010 Population	2015 Population	2040 Population	% Change 2010-2040	Total Growth
Navajo County	107,677	109,671	120,094	11.53%	12,417
Holbrook	5,053	5,094	5,606	10.94%	553
Snowflake	5,590	5,742	7,347	31.43%	1,757
Taylor	4,112	4,208	5,554	35.07%	1,442
Show Low	10,660	11,061	15,154	42.16%	4,494

Source: U.S. Census, Arizona Department of Administration – Employment and Population Statistics

### Major Traffic Generators

The Town of Snowflake, Town of Taylor, City of Holbrook and City of Show Low are major traffic generators for the SR 77 corridor.

### Tribes

The Hopi (to the West), Pueblo of Zuni (to the East) and White Mountain Apache (to the South) Reservations are near the corridor but not immediately adjacent to it.

### Wildlife Linkages

The Arizona State Wildlife Action Plan (SWAP) provides a 10-year vision for the entire state, identifying wildlife and habitats in need of conservation, insight regarding the stressors to those resources, and actions that can be taken to alleviate those stressors. Using the Habimap Tool that creates an interactive database of information included in the SWAP, the following were identified in relation to the SR 77 corridor:

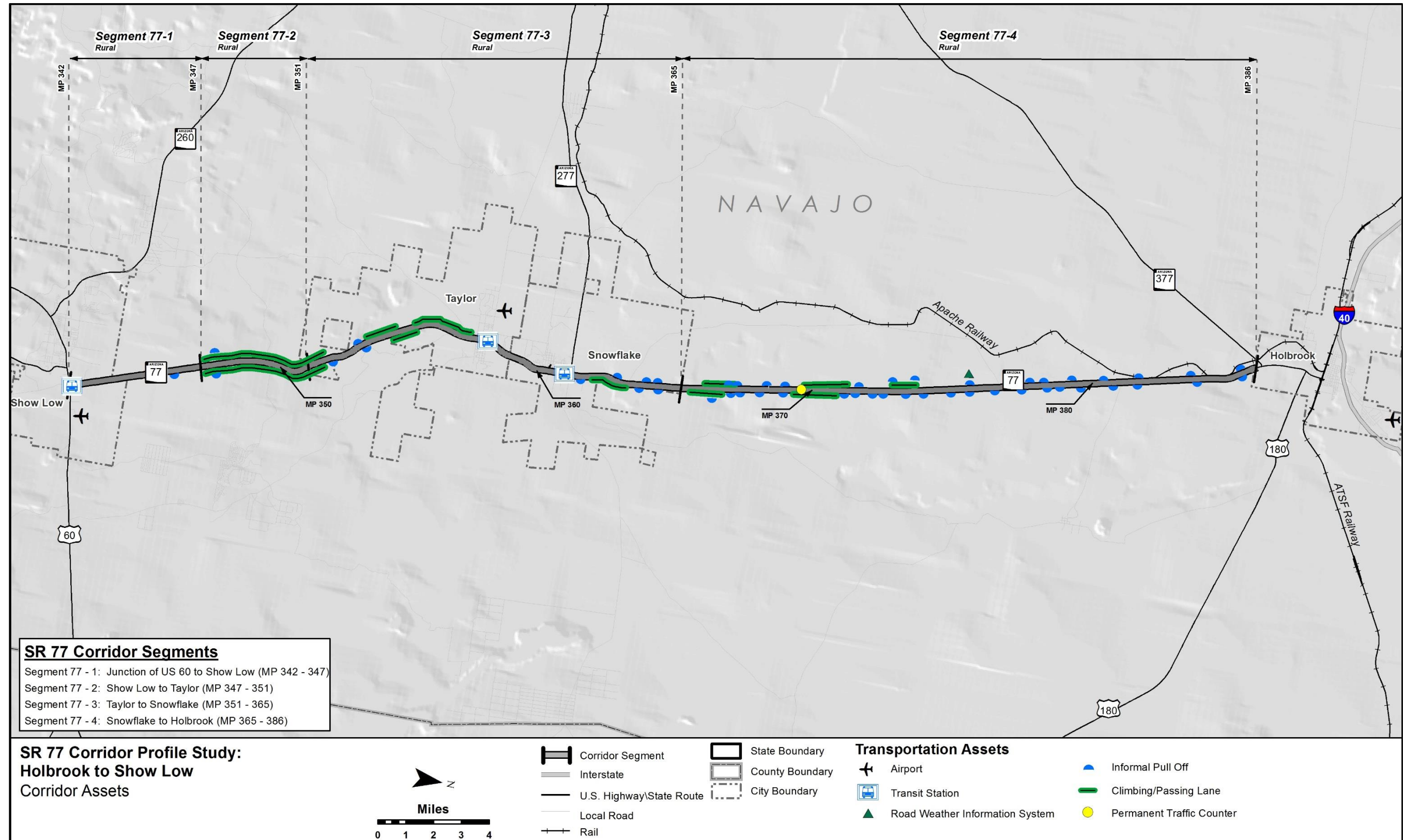
- Two Arizona Game and Fish Department (AGFD) Wildlife Waters are located near the corridor, specifically on the west side of SR 77 between Holbrook and Snowflake
- Arizona Important Bird Areas: there were no Important Bird Areas identified within the study limits of the SR 77 corridor
- The corridor travels through allotments controlled by the Arizona State Land Department (ASLD), BLM, and United States Forest Service
- Riparian areas include areas with high level adjacent to SR 77 near Show Low, and a large concentration of high level Riparian crossings between MP 356- MP 362 and near MP 376

- Arizona Wildlife Linkages: No missing linkages are noted, but there are potential Arizona Wildlife Linkage Zones along SR 77 from MP 349 northbound to the end of the corridor limits
- According to the Species and Habitat Conservation Guide (SHCG), sensitive habitats that have moderate to high conservation potential exist near the SR 77 and Show Low Junction and in the northern portion of the corridor
- Areas where Species of Greatest Conservation Need (SGCN) are high or moderately vulnerable are similar to the areas identified in the SHCG (see above)
- Identified areas of moderate or high levels of Species of Economic and Recreational Importance (SERI) are in the southern vicinity of SR 77, from approximately MP 350 to MP 342.2

### Corridor Assets

Corridor transportation assets are summarized in **Figure 3**. There are six passing lanes on SR 77 between MP 345 and MP 376. Other assets include a Road Weather Information System (RWIS) device located MP 374, and three transit (bus) stations; one in Snowflake; one in Taylor; and one in Show Low. The transit service terminates outside of the SR 77 corridor in Holbrook.

Figure 3: Corridor Assets



## 1.6 Corridor Stakeholders and Input Process

A Technical Advisory Committee (TAC) was created that was comprised of representatives from key stakeholders. TAC meetings were held at key milestones to present results and obtain feedback. In addition, several meetings were conducted with key stakeholders between February 2016 and October 2016 to present the results and obtain feedback.

Key stakeholders identified for this study included:

- ADOT Northeast District
- ADOT Technical Groups
- NACOG
- AZGFD
- ASLD
- Federal Highway Administration (FHWA)
- Apache-Sitgreaves National Forest

Two draft report documents will be prepared during the development of the CPS. The first draft document includes the corridor performance evaluation and needs assessment (this report). The second draft document includes the solution development, evaluation and prioritization. Both will be provided to the TAC for review and comment, then combined into a comprehensive final report.



## 1.7 Prior Studies and Recommendations

This study identified recommendations from previous studies, plans, and preliminary design documents. Studies, plans, and programs pertinent to the SR 77 corridor were reviewed to understand the full context of future planning and design efforts within and around the study area. These studies are organized below into four categories: Framework and Statewide Studies, Regional Planning Studies, Planning Assistance for Rural Areas (PARAs) and Small Area Transportation Studies (SATS), and Design Concept Reports (DCRs) and Project Assessments (PAs).

### Framework and Statewide Studies

- ADOT Bicycle and Pedestrian Plan Update (2013)
- ADOT Pedestrian Safety Action Plan (2017)
- ADOT Five-Year Transportation Facilities Construction Program (2018 – 2022)
- ADOT Climbing and Passing Lane Prioritization Study (2015)
- ADOT Arizona Key Commerce Corridors (2014)
- ADOT Arizona Multimodal Freight Analysis Study (2009)
- ADOT Arizona Ports of Entry Study (2013)
- ADOT Arizona State Airport Systems Plan (2008)
- ADOT Arizona State Freight Plan (2016)
- ADOT Arizona State Rail Plan (2011)
- AGFD Arizona State Wildlife Action Plan (2012) / Arizona Wildlife Linkages Assessment
- ADOT Arizona Statewide Dynamic Message Sign Master Plan (2011)
- ADOT Arizona Statewide Rail Framework Study (2010)
- ADOT Arizona Statewide Rest Area Study (2011)
- ADOT Arizona Statewide Shoulders Study (2015)
- ADOT Arizona Strategic Highway Safety Plan (2014)
- ADOT Arizona Roadway Departure Safety Implementation Plan (RDSIP) (2014)
- ADOT AASHTO U.S. Bicycle Route System (2015)
- ADOT Low Volume State Routes Study (2017)
- ADOT Statewide Transportation Planning Framework – Building a Quality Arizona (BQAZ) (2010)
- ADOT Eastern Arizona Framework Study (2009)
- ADOT What Moves You Arizona? Long-Range Transportation Plan (2010-2035)

### Regional Planning Studies

- Southern Navajo/Apache County Sub Regional Transportation Plan (2007)
- NACOG, Regional Transportation Improvement Program (2017)
- Traffic Impact Statement for the Intersection of US 60 and SR 77: Show Low to Little Mormon Lake (2014)

### Planning Assistance for Rural Areas and Small Area Transportation Studies

- Second Knolls Development Multimodal Transportation Study (2014)
- Snowflake/Taylor Multijurisdictional Transportation Plan (2011)
- Show Low Trails and Transit Connectivity Study (2014)
- Navajo County Central Region Transportation Study (2010)

### Design Concept Reports and Project Assessments

- SR 77: Show Low – Shumway Unit II – Design Concept Report (1990)
- SR 77: Five Mile Draw Bridge – Project Assessment (2011) Bridge replacement Constructed 2015 (does not show in bridge inventory)
- SR 77: Initial Show Low to Taylor Design Concept Report (2012)
- Traffic Impact Statement for the Intersection of US 60 and SR 77: Final Design (2012) (work included in the SR77/US60 – MP352 project currently under construction)

### Summary of Prior Recommendations

Various studies and plans, including several DCRs and PAs, have recommended improvements to the SR 77 corridor as shown in **Table 3** and **Figure 4**. They include, but are not limited to:

- Widening of numerous sections of SR 77, some of which may require right-of-way acquisition; many other proposed improvements are associated with the recommended widening:
  - Adding one general purpose lane in each direction from MP 342 to MP 347 and from MP 365 to MP 387
- There are recommended investments associated with intersections including:
  - Intersection improvements
  - New TI at MP 342.2
  - Incorporating traffic signals at MP 349.3 and MP 357.4
  - Incorporating a grade-separated intersection at MP 349.5
- Various locations along SR 77 have recommendations for improving bridge infrastructure and implementing wildlife crossings.

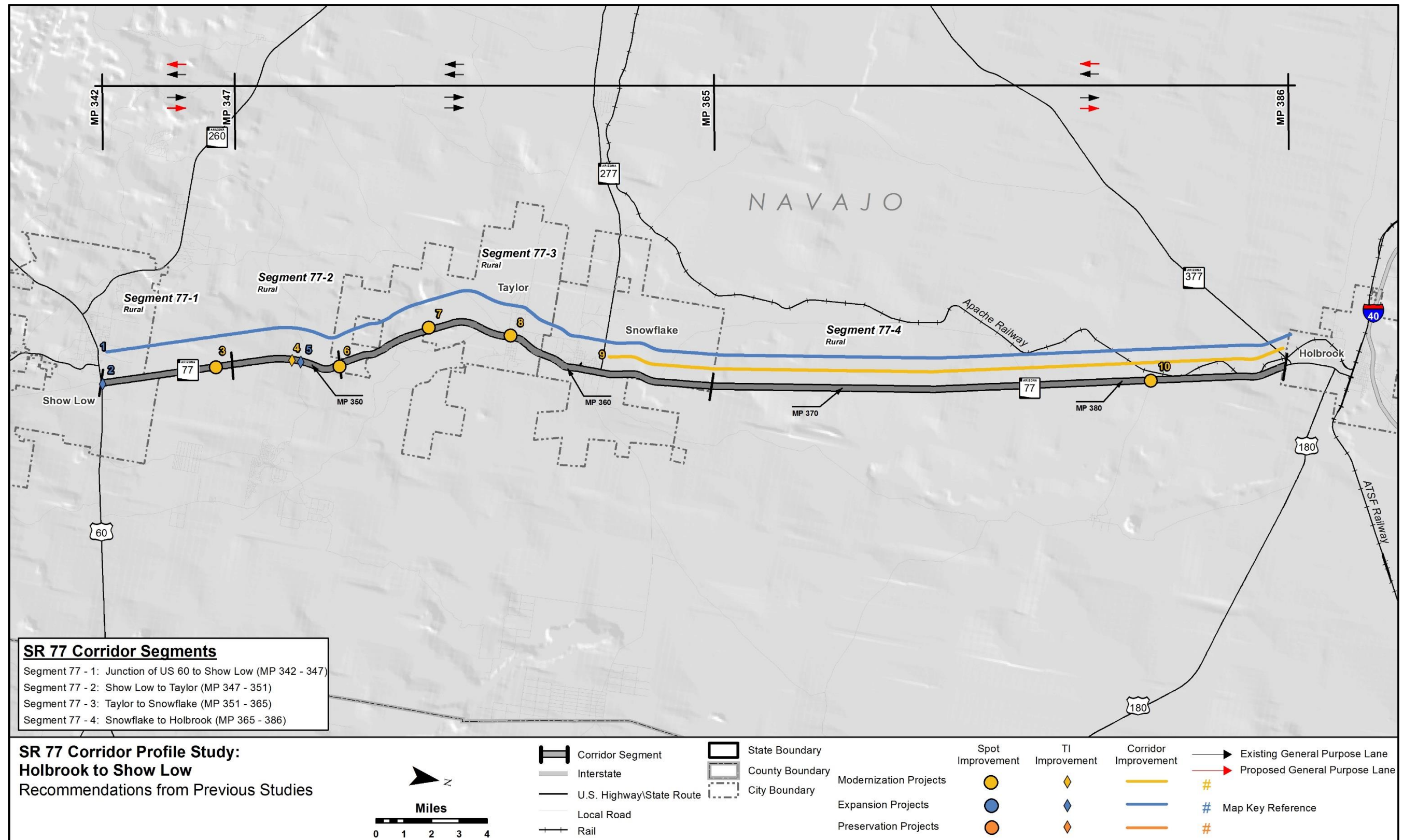
**Table 3: Corridor Recommendations from Previous Studies**

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
SR 77											
1	342	386	45.0	SR 77 Roadway Widening Show Low to Holbrook <ul style="list-style-type: none"><li>Widen to divided four-lane facility from Show Low to Taylor</li><li>Fence replacement, culvert extensions, new rumble strips, roadway markings, turnout treatments NB MP 365.39 and SB MP 365.66</li><li>Add passing lanes: NB/SB MP 365.20 to MP 366.50 and MP 369.10 to MP 370.60</li></ul>			√	2030	N/A	Y	Southern Navajo/Apache County Sub Regional Transportation Plan (2007)  Eastern Arizona Framework Study (2009)  Building and Quality Arizona (BQAZ) (2010)  SR 77: Show Low to Taylor DCR (MP 342.2 – MP 357.4) (2012)  Navajo County Central Region Transportation Study (2010)
2	342.2	342.2	0.0	New TI: US 60 at SR 77 and SR 77 at Silver Lake Blvd; signal timing may be required in future			√	2030	N/A	N	Southern Navajo/Apache County Sub Regional Transportation Plan (2007)  Traffic Impact Statement for the Intersection of US 60 and SR 77: Show Low to Little Mormon Lake (2014)
3	347	347	0.0	Wildlife Crossing: overpass/underpass		√		-	N/A	Y	SR 77: Show Low to Taylor DCR (MP 342.2 – MP 357.4) (2012)
4	349.3	349.3	0.0	SR 77/Lone Pine Dam Rd: signal (2015)		√		-	N/A	N	Southern Navajo/Apache County Sub Regional Transportation Plan (2007)
5	349.5	349.5	0.0	Grade Separated Intersection: SR 77 and White Mountain Lake Road			√	2030	N/A	N	Southern Navajo/Apache County Sub Regional Transportation Plan (2007)
6	351	352	1.0	Wildlife Crossing: overpass/underpass		√		-	N/A	Y	SR 77: Show Low to Taylor DCR (MP 342.2 – MP 357.4) (2012)

**Table 3: Corridor Recommendations from Previous Studies (continued)**

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
7	354.4	354.4	0.0	Wildlife Crossing: underpass		√		-	N/A	Y	SR 77: Show Low to Taylor DCR (MP 342.2 – MP 357.4) (2012)
8	357.4	357.4	0.0	Intersection Signal: SR 77 and Pinedale Road		√		-	N/A	N	Southern Navajo/Apache County Sub Regional Transportation Plan (2007)
9	361	386	25	Bridge Infrastructure Improvements with immediate needs between Snowflake and Holbrook		√		-	N/A	N	Arizona Key Commerce Corridors (2014)
10	380	380	0.0	NB DMS MP 380		√		-	N/A	N	Arizona Statewide Dynamic Message Master Plan (2011)

Figure 4: Corridor Recommendations from Previous Studies





## 2.0 CORRIDOR PERFORMANCE

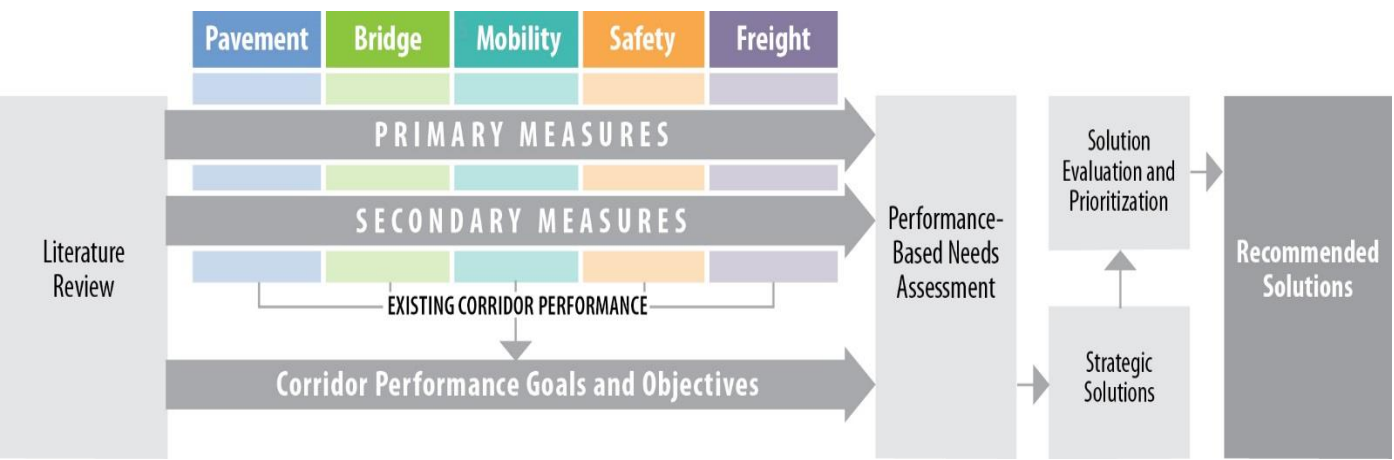
This chapter describes the evaluation of the existing performance of the SR 77 corridor. A series of performance measures is used to assess the corridor. The results of the performance evaluation are then used to define corridor needs relative to the long-term goals and objectives for the corridor.

### 2.1 Corridor Performance Framework

This study employs a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

**Figure 5** illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance. The primary measures in each of five performance areas are used to define the overall health of the corridor, while the secondary measures identify locations that warrant further diagnostic investigation to delineate needs. Needs are defined as the difference between baseline corridor performance and established performance objectives.

**Figure 5: Corridor Profile Performance Framework**



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

These performance areas reflect national performance goals stated in *Moving Ahead for Progress in the 21<sup>st</sup> Century* (MAP-21):

- Safety: To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
- Infrastructure Condition: To maintain the highway infrastructure asset system in a state of good repair
- Congestion Reduction: To achieve a significant reduction in congestion on the National Highway System
- System Reliability: To improve the efficiency of the surface transportation system
- Freight Movement and Economic Vitality: To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
- Environmental Sustainability: To enhance the performance of the transportation system while protecting and enhancing the natural environment
- Reduced Project Delivery Delays: To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion

The MAP-21 performance goals were considered in the development of ADOT's P2P process, which integrates transportation planning with capital improvement programming and project delivery. Because the P2P program requires the preparation of annual transportation system performance reports using the five performance areas adopted for the CPS, consistency is achieved in the performance measures used for various ADOT analysis processes.

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance.

Each of the primary and secondary performance measures is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

- Good/Above Average Performance** – Rating is above the identified desirable/average range
- Fair/Average Performance** – Rating is within the identified desirable/average range
- Poor/Below Average Performance** – Rating is below the identified desirable/average range

**Table 4** provides the complete list of primary and secondary performance measures for each of the five performance areas.

**Table 4: Corridor Performance Measures**

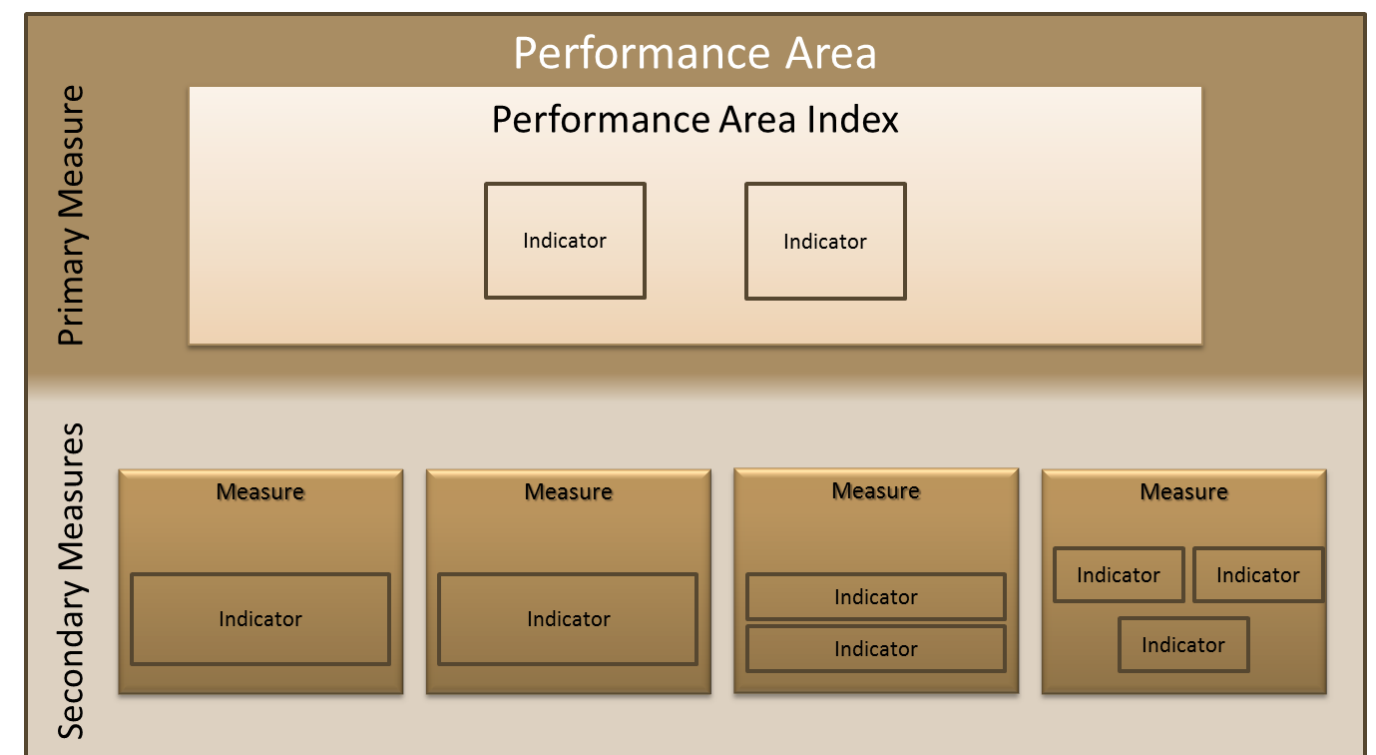
Performance Area	Primary Measure	Secondary Measures
<b>Pavement</b>	<b>Pavement Index</b> Based on a combination of International Roughness Index and cracking	<ul style="list-style-type: none"> <li>Directional Pavement Serviceability</li> <li>Pavement Failure</li> <li>Pavement Hot Spots</li> </ul>
<b>Bridge</b>	<b>Bridge Index</b> Based on lowest of deck, substructure, superstructure and structural evaluation rating	<ul style="list-style-type: none"> <li>Bridge Sufficiency</li> <li>Functionally Obsolete Bridges</li> <li>Bridge Rating</li> <li>Bridge Hot Spots</li> </ul>
<b>Mobility</b>	<b>Mobility Index</b> Based on combination of existing and future daily volume-to-capacity ratios	<ul style="list-style-type: none"> <li>Future Congestion</li> <li>Peak Congestion</li> <li>Travel Time Reliability</li> <li>Multimodal Opportunities</li> </ul>
<b>Safety</b>	<b>Safety Index</b> Based on frequency of fatal and incapacitating injury crashes	<ul style="list-style-type: none"> <li>Directional Safety Index</li> <li>Strategic Highway Safety Plan Emphasis Areas</li> <li>Crash Unit Types</li> <li>Safety Hot Spots</li> </ul>
<b>Freight</b>	<b>Freight Index</b> Based on bi-directional truck planning time index	<ul style="list-style-type: none"> <li>Recurring Delay</li> <li>Non-Recurring Delay</li> <li>Closure Duration</li> <li>Bridge Vertical Clearance</li> <li>Bridge Vertical Clearance Hot Spots</li> </ul>

The general template for each performance area is illustrated in **Figure 6**.

The guidelines for performance measure development are:

- Indicators and performance measures for each performance area should be developed for relatively homogeneous corridor segments
- Performance measures for each performance area should be tiered, consisting of primary measure(s) and secondary measure(s)
- Primary and secondary measures should assist in identifying those corridor segments that warrant in-depth diagnostic analyses to identify performance-based needs and a range of corrective actions known as solution sets
- One or more primary performance measures should be used to develop a Performance Index to communicate the overall health of a corridor and its segments for each performance area; the Performance Index should be a single numerical index that is quantifiable, repeatable, scalable, and capable of being mapped; primary performance measures should be transformed into a Performance Index using mathematical or statistical methods to combine one or more data fields from an available ADOT database
- One or more secondary performance measure indicators should be used to provide additional details to define corridor locations that warrant further diagnostic analysis; secondary performance measures may include the individual indicators used to calculate the Performance Index and/or “hot spot” features

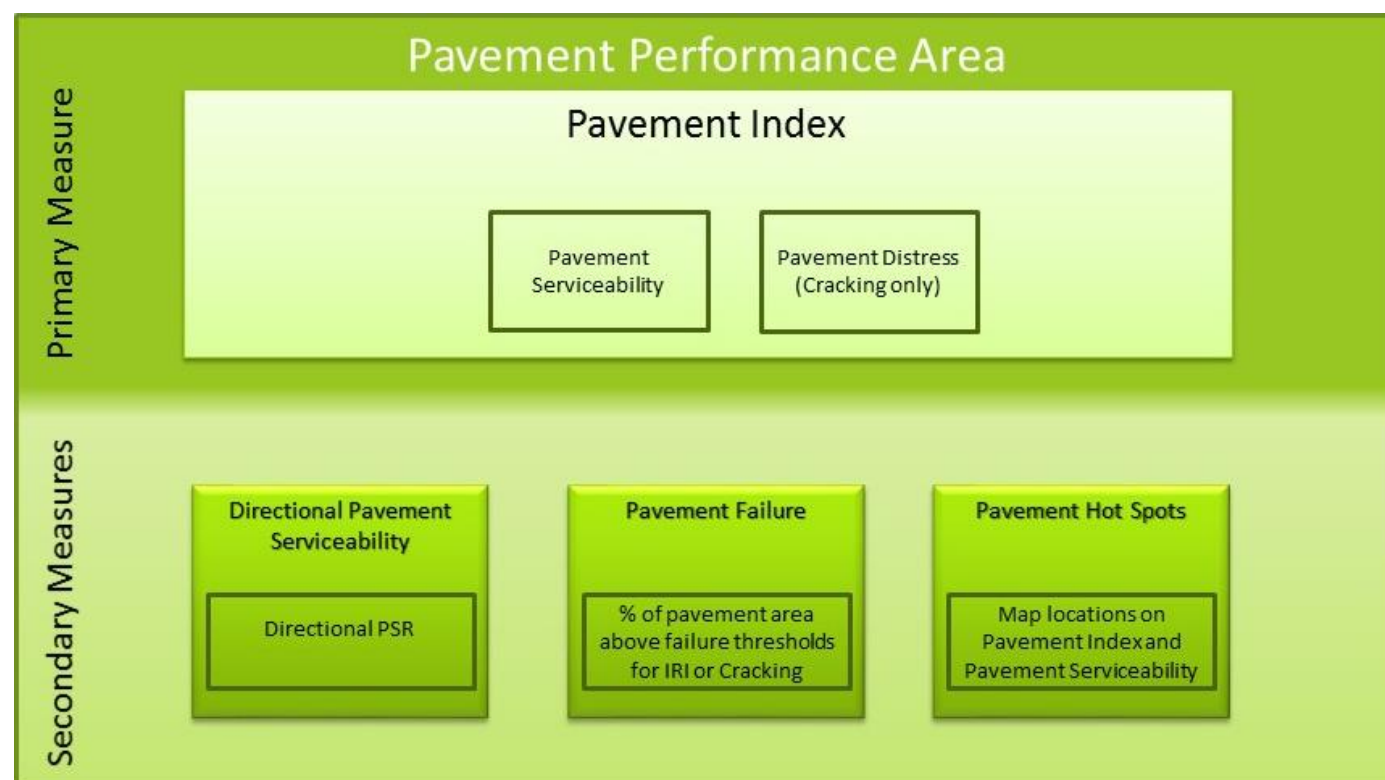
**Figure 6: Performance Area Template**



## 2.2 Pavement Performance Area

The Pavement performance area consists of a primary measure (Pavement Index) and three secondary measures, as shown in **Figure 7**. These measures assess the condition of the existing pavement along the SR 77 corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

**Figure 7: Pavement Performance Measures**



### Primary Pavement Index

The Pavement Index is calculated using two pavement condition ratings: the Pavement Serviceability Rating (PSR) and the Pavement Distress Index (PDI).

The PSR is extracted from the International Roughness Index (IRI), a measurement of pavement roughness based on field-measured longitudinal roadway profiles. The PDI is extracted from the Cracking Rating (CR), a field-measured sample from each mile of highway.

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than the condition of a section with fewer travel lanes.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Pavement performance area, the relevant operating environments are designated as interstate and non-interstate segments. For the SR 77 corridor, the following operating environment was identified:

- Non-interstate: all segments

### Secondary Pavement Measures

Three secondary measures provide an in-depth evaluation of the different characteristics of pavement performance.

#### Directional Pavement Serviceability

- Weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel

#### Pavement Failure

- Percentage of pavement area rated above failure thresholds for IRI or Cracking

#### Pavement Hot Spots

- A Pavement “hot spot” exists where a given one-mile section of roadway rates as being in “poor” condition
- Highlights problem areas that may be under-represented in a segment average; this measure is recorded and mapped, but not included in the Pavement performance area rating calculations

### Pavement Performance Results

The Pavement Index provides a high-level assessment of the pavement condition for the corridor and for each segment. The three secondary measures provide more detailed information to assess pavement performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Pavement Index shows “good” overall performance for SR 77
- All segments have “good” % Pavement Area Failure ratings
- There were no pavement hot spots along the corridor

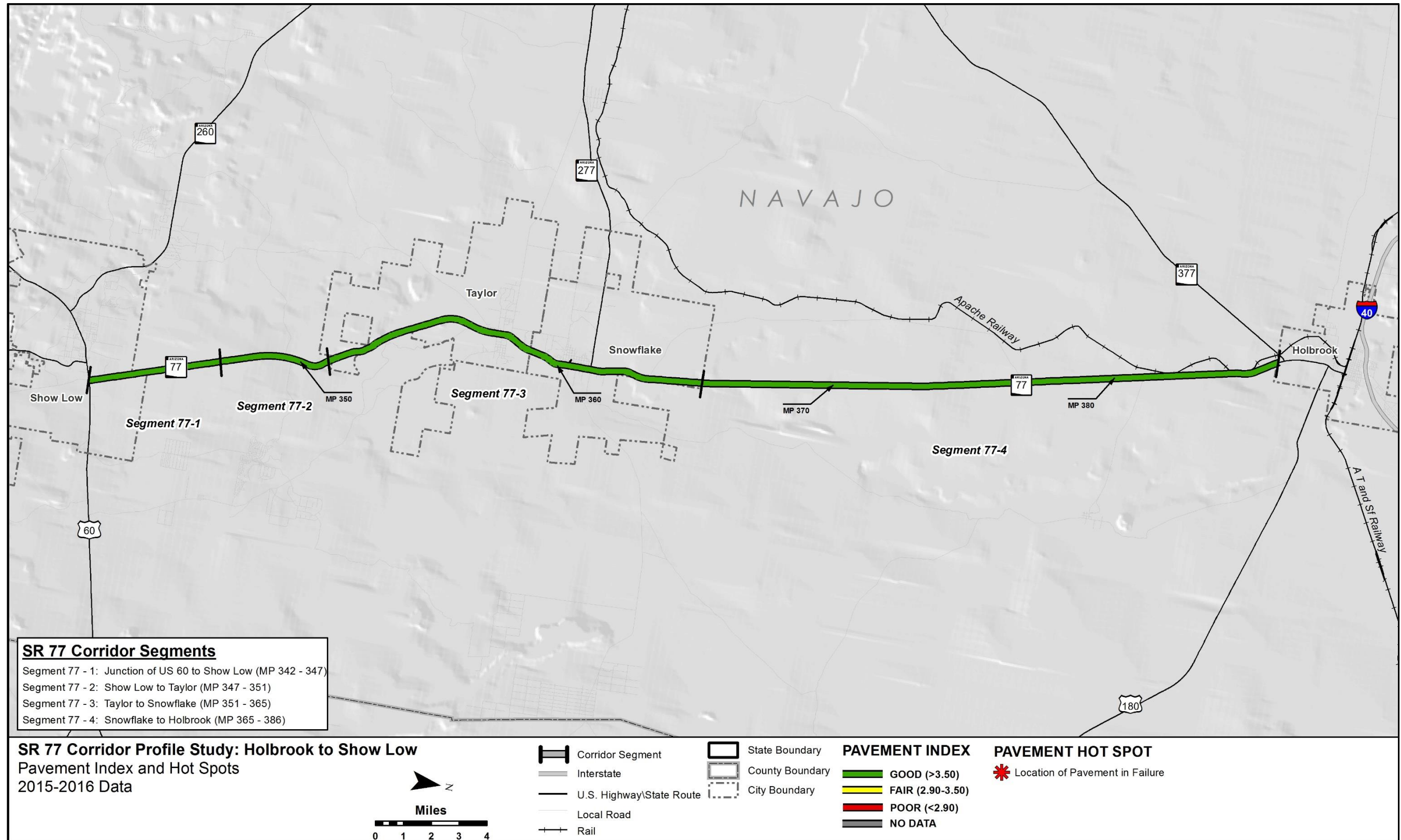
**Table 5** summarizes the Pavement performance results for the SR 77 corridor. **Figure 8** illustrates the primary Pavement Index performance and locations of Pavement hot spots along the SR 77 corridor. Maps for each secondary measure can be found in **Appendix A**.

**Table 3: Pavement Performance**

Segment #	Segment Length (miles)	Pavement Index	Directional PSR		% Area Failure
			NB	SB	
77-1	5	3.97	3.94		0%
77-2	4	3.79	3.89		0%
77-3	14	4.06	3.72		0%
77-4	21	3.82	3.81		0%
Weighted Corridor Average		3.91	3.80		0%
SCALES					
Performance Level		Non-Interstate			
Good		> 3.50			< 5%
Fair		2.90 - 3.50			5% - 20%
Poor		< 2.90			> 20%



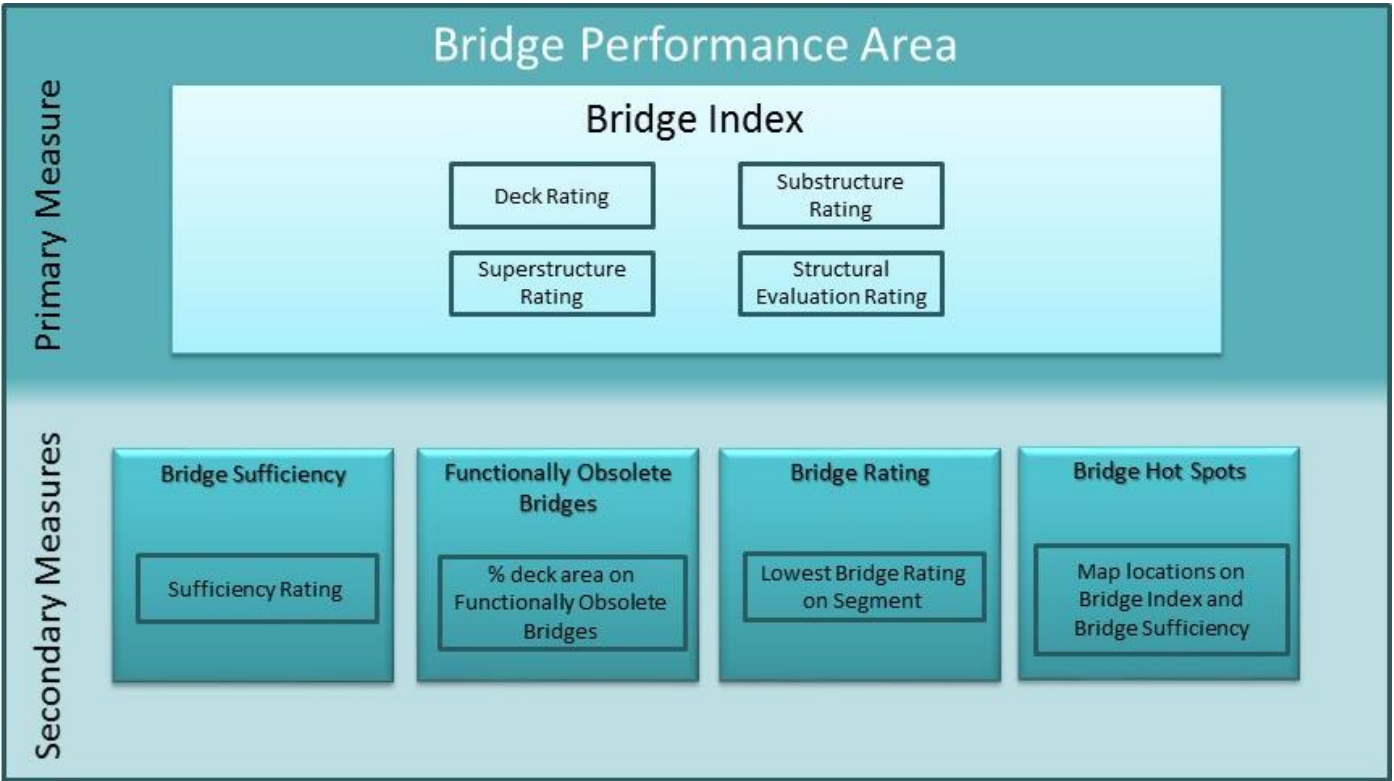
Figure 8: Pavement Performance



### 2.3 Bridge Performance Area

The Bridge performance area consists of a primary measure (Bridge Index) and four secondary measures, as shown in **Figure 9**. These measures assess the condition of the existing bridges along the SR 77 corridor. Only bridges that carry mainline traffic or bridges that cross the mainline are included in the calculation. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

**Figure 9: Bridge Performance Measures**



#### Primary Bridge Index

The Bridge Index is calculated based on the use of four different bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. These ratings are based on inspection reports and establish the structural adequacy of each bridge. The performance of each individual bridge is established by using the lowest of these four ratings. The use of these ratings, and the use of the lowest rating, is consistent with the approach used by the ADOT Bridge Group to assess the need for bridge rehabilitation. The Bridge Index is calculated as a weighted average for each segment based on deck area.

#### Secondary Bridge Measures

Four secondary measures provide an in-depth evaluation of the characteristics of each bridge:

##### Bridge Sufficiency

- Multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour
- Rates the structural and functional sufficiency of each bridge on a 100-point scale

##### Functionally Obsolete Bridges

- Percentage of total deck area in a segment that is on functionally obsolete bridges
- Identifies bridges that no longer meet standards for current traffic volumes, lane width, shoulder width, or bridge rails
- A bridge that is functionally obsolete may still be structurally sound

##### Bridge Rating

- The lowest rating of the four bridge condition ratings (substructure, superstructure, deck, and structural evaluation) on each segment
- Identifies lowest performing evaluation factor on each bridge

##### Bridge Hot Spots

- A Bridge “hot spot” is identified where a given bridge has a bridge rating of 4 or lower or multiple ratings of 5 between the deck, superstructure, and substructure ratings
- Identifies particularly low-performing bridges or those that may decline to low performance in the immediate future

#### Bridge Performance Results

The Bridge Index provides a high-level assessment of the structural condition of bridges for the corridor and for each segment. The four secondary measures provide more detailed information to assess bridge performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Bridge Index shows “good” overall performance for the SR 77 corridor
- Two segments contain bridges, and both have a “good” Bridge Index rating
- Segment 77-3 has a “good” Sufficiency Rating and Segment 77-4 has a “fair” Sufficiency Rating
- There are three functionally obsolete bridge in Segment 77-4 (Seven Mile Draw Bridge (No. 279), Bridge (No. 280), Washboard Wash Bridge, No.198))
- All segments that contain bridges have a “fair” or “good” Lowest Bridge Rating
- One bridge hot spot bridge exists on the corridor, Washboard Wash Bridge, No.198

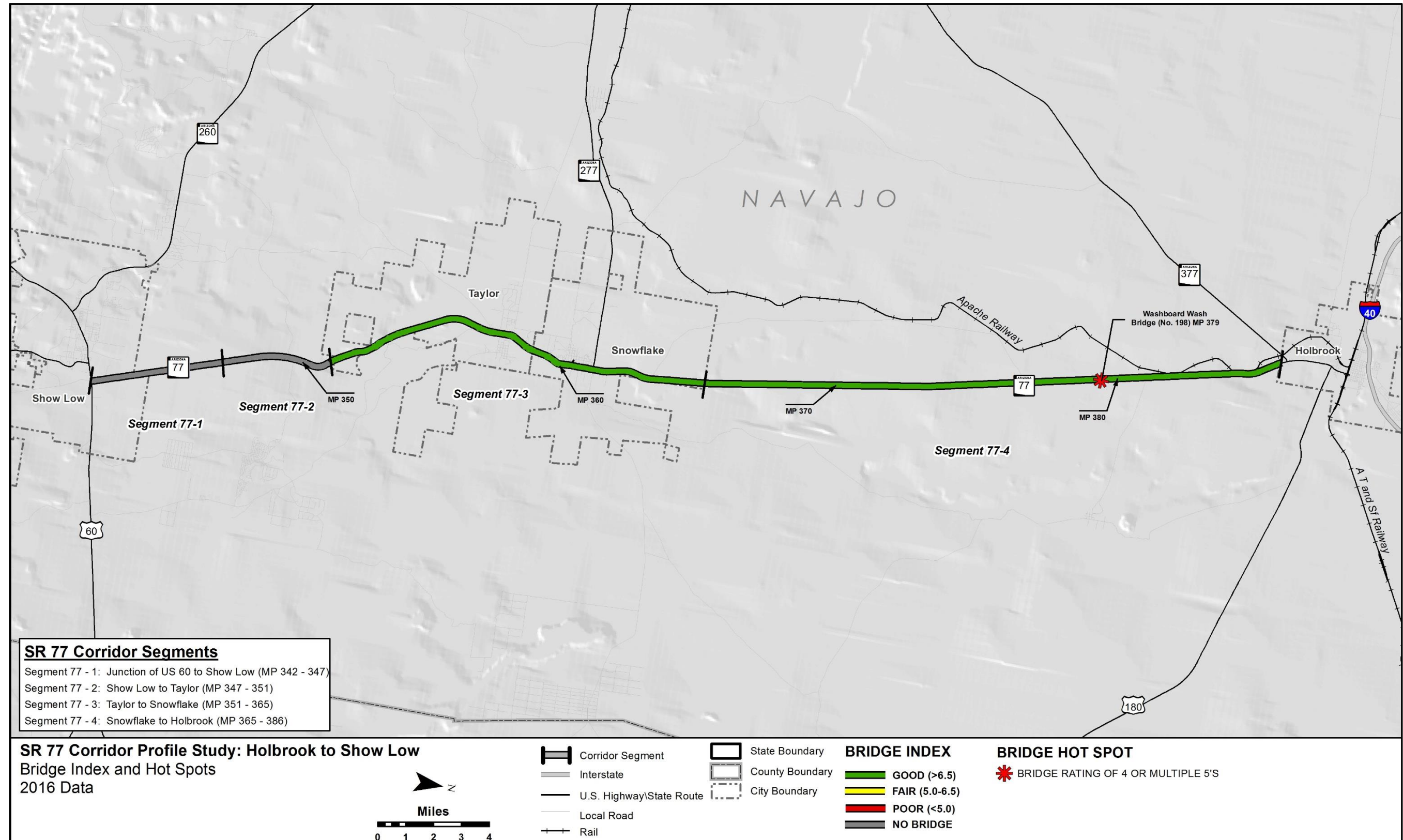
**Table 6** summarizes the Bridge performance results for the SR 77 corridor. **Figure 10** illustrates the primary Bridge Index performance and locations of Bridge hot spots along the SR 77 corridor. Maps for each secondary measure can be found in **Appendix A**.

**Table 6: Bridge Performance**

Segment #	Segment Length (miles)	# of Bridges	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating
77-1	5	0	No Bridges			
77-2	4	0	No Bridges			
77-3	14	1	7.00	87.30	0.0%	7
77-4	21	4	6.74	72.46	48.8%	5
Weighted Corridor Average			6.79	75.43	39%	5.40
SCALES						
Performance Level			All			
Good			> 6.5	> 80	< 12%	> 6
Fair			5.0 - 6.5	50 - 80	12% - 40%	5 - 6
Poor			< 5.0	< 50	> 40 %	< 5



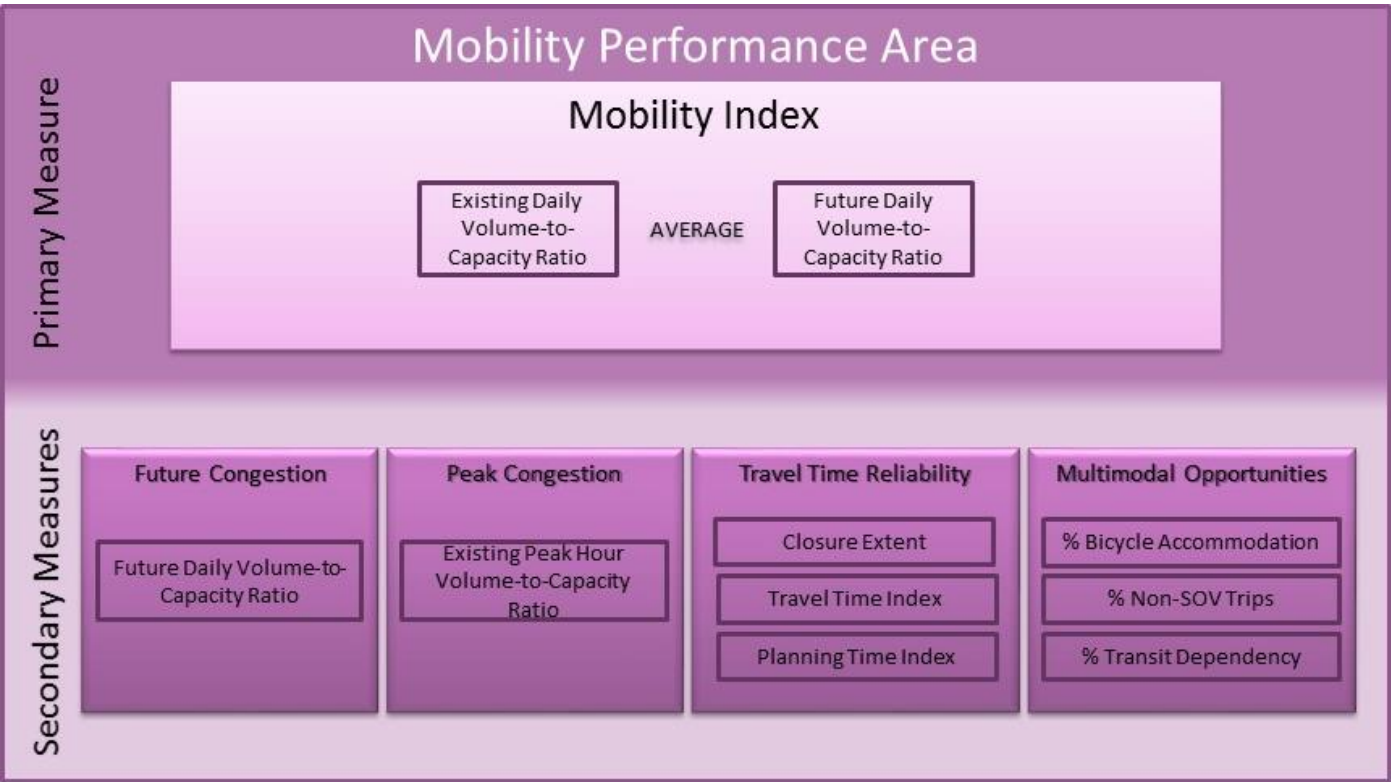
Figure 10: Bridge Performance



## 2.4 Mobility Performance Area

The Mobility performance area consists of a primary measure (Mobility Index) and four secondary measures, as shown in **Figure 11**. These measures assess the condition of existing mobility along the SR 77 corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

**Figure 11: Mobility Performance Measures**



### Primary Mobility Index

The Mobility Index is an average of the existing (2014) daily volume-to-capacity (V/C) ratio and the future (2035 AZTDM) daily V/C ratio for each segment of the corridor. The V/C ratio is an indicator of the level of congestion. This measure compares the average annual daily traffic (AADT) volume to the capacity of the corridor segment as defined by the service volume for level of service (LOS) E. By using the average of the existing and future year daily volumes, this index measures the level of daily congestion projected to occur in approximately ten years (2025) if no capacity improvements are made to the corridor.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Mobility performance area, the relevant operating environments are urban vs. rural setting and interrupted flow (e.g., signalized at-grade intersections are present) vs. uninterrupted

flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway). For the SR 77 corridor, the following operating environments were identified:

- Rural Uninterrupted Flow: Segments 77-1, 77-2, and 77-4
- Rural Interrupted Flow: Segment 77-3

### Secondary Mobility Measures

Four secondary measures provide an in-depth evaluation of operational characteristics of the corridor:

#### *Future Congestion – Future Daily V/C*

- The future (2035 AZTDM) daily V/C ratio; this measure is the same value used in the calculation of the Mobility Index
- Provides a measure of future congestion if no capacity improvements are made to the corridor

#### *Peak Congestion – Existing Peak Hour V/C*

- The peak hour V/C ratio for each direction of travel
- Provides a measure of existing peak hour congestion during typical weekdays

*Travel Time Reliability*– Three separate travel time reliability indicators together provide a comprehensive picture of how much time may be required to travel within the corridor:

- Closure Extent:
  - The average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average was applied to each closure that takes into account the distance over which the closure occurs
  - Closures related to crashes, weather, or other incidents are a significant contributor to non-recurring delays; construction-related closures were excluded from the analysis
- Directional Travel Time Index (TTI):
  - The ratio of the average peak period travel time to the free-flow travel time (based on the posted speed limit) in a given direction
  - The TTI recognizes the delay potential from recurring congestion during peak periods; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics
- Directional Planning Time Index (PTI):
  - The ratio of the 95<sup>th</sup> percentile travel time to the free-flow travel time (based on the posted speed limit) in a given direction
  - The PTI recognizes the delay potential from non-recurring delays such as traffic crashes, weather, or other incidents; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics

- The PTI indicates the amount of time in addition to the typical travel time that should be allocated to make an on-time trip 95% of the time in a given direction

*Multimodal Opportunities* – Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to the single occupancy vehicle (SOV) for trips along the corridor:

- % Bicycle Accommodation:
  - Percentage of the segment that accommodates bicycle travel; bicycle accommodation on the roadway or on shoulders varies depending on traffic volumes, speed limits, and surface type
  - Encouraging bicycle travel has the potential to reduce automobile travel, especially on non-interstate highways
- % Non-SOV Trips:
  - The percentage of trips (less than 50 miles in length) by non-SOVs
  - The percentage of non-SOV trips in a corridor gives an indication of travel patterns along a section of roadway that could benefit from additional multimodal options
- % Transit Dependency:
  - The percentage of households that have zero or one automobile and households where the total income level is below the federally defined poverty level
  - Used to track the level of need among those who are considered transit dependent and more likely to utilize transit if it is available

#### Mobility Performance Results

The Mobility Index provides a high-level assessment of mobility conditions for the corridor and for each segment. The four secondary measures provide more detailed information to assess mobility performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Mobility Index shows “good” overall performance for SR 77
- During the existing peak hour, traffic operations are “good” for all segments
- All segments are anticipated to have “good” performance in the future, according to the Future Daily V/C performance indicator
- All segments have “fair” performance in the Closure Extent performance indicator for NB travel; Segments 77-1, 77-2, and 77-3 “poor” performance in the Closure Extent performance indicator for SB travel
- The TTI performance indicator shows that all segments on the SR 77 corridor performance are at “good” performance levels in both directions
- The PTI performance indicator shows that Segments 77-3 and 77-4 have “good” performance in both directions, while Segments 77-1 and 77-2 have “poor” performance in terms of reliability

- All segments show “fair” performance for non-SOV trips, indicating single occupant trips are more common
- Most the corridor shows “poor” performance in % Bicycle Accommodation, indicating most of the corridor has narrow shoulders, except for Segment 77-1 which has “good” performance

**Table 7** summarizes the Mobility performance results for the SR 77 corridor. **Figure 12** illustrates the primary Mobility Index performance along the SR 77 corridor. Maps for each secondary measure can be found in **Appendix A**.

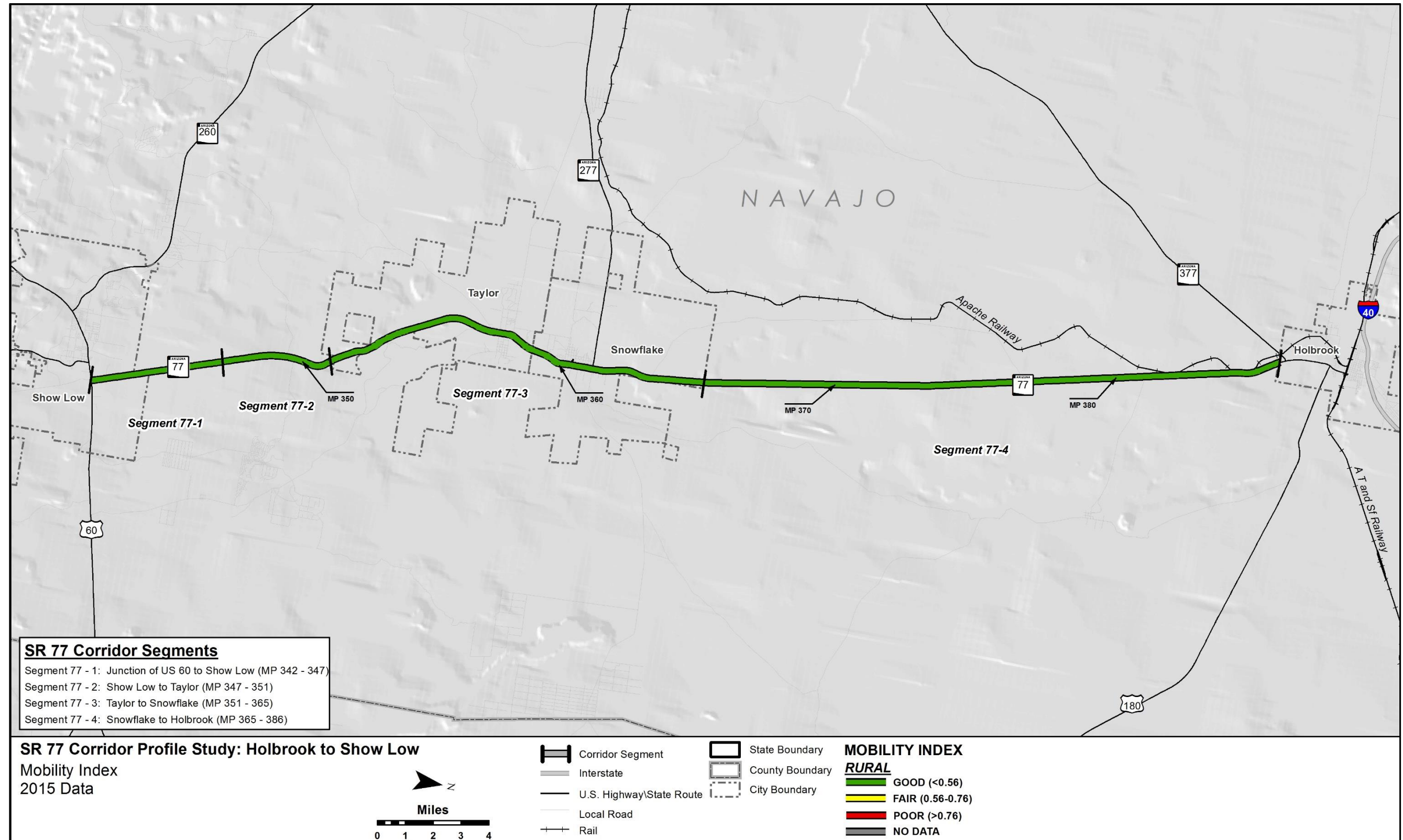


Table 7: Mobility Performance

Segment #	Segment Length (miles)	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
				NB	SB	NB	SB	NB	SB	NB	SB		
77-1 <sup>2^</sup> ^	5	0.47	0.55	0.30	0.30	0.43	1.40	1.07	1.04	2.38	2.57	97%	12.9%
77-2 <sup>2^</sup> ^	4	0.16	0.18	0.10	0.10	0.50	1.40	1.09	1.14	1.23	2.20	13%	13.6%
77-3 <sup>2^</sup> *	14	0.48	0.56	0.32	0.32	0.33	1.04	1.09	1.09	1.83	1.80	36%	16.9%
77-4 <sup>2^</sup> ^	21	0.13	0.15	0.11	0.10	0.44	0.04	1.01	1.02	1.17	1.22	0%	14.5%
Weighted Corridor Average		0.28	0.33	0.20	0.19	0.41	0.64	1.05	1.06	1.52	1.65	24%	15%
SCALES													
Performance Level		Urban Rural		All		Uninterrupted Interrupted		All					
Good		< 0.71 <sup>1</sup> < 0.56 <sup>2</sup>		< 0.22		< 1.15^ < 1.30*		< 1.30^ < 3.00*		> 90%		> 17%	
Fair		0.71 - 0.89 <sup>1</sup> 0.56 - 0.76 <sup>2</sup>		0.22 – 0.62		1.15 - 1.33^ 1.30 - 2.00*		1.30 - 1.50^ 3.00 - 6.00*		60% - 90%		11% - 17%	
Poor		> 0.89 <sup>1</sup> > 0.76 <sup>2</sup>		> 0.62		> 1.33^ > 2.00*		> 1.50^ > 6.00*		< 60%		< 11%	

<sup>1</sup>Urban Operating Environment  
<sup>2</sup>Rural Operating Environment  
<sup>^</sup>Uninterrupted Flow Facility  
<sup>\*</sup>Interrupted Flow Facility

Figure 12: Mobility Performance





## 2.5 Safety Performance Area

The Safety performance area consists of a primary measure (Safety Index) and four secondary measures, as illustrated in **Figure 13**. All measures relate to crashes that result in fatal and incapacitating injuries, as these types of crashes are the emphasis of the ADOT Strategic Highway Safety Plan (SHSP), FHWA, and MAP-21. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

**Figure 13: Safety Performance Measures**



### Primary Safety Index

The Safety Index is based on the bi-directional frequency and rate of fatal and incapacitating injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT’s 2010 Highway Safety Improvement Program Manual, fatal crashes have an estimated cost that is 14.5 times the estimated cost of incapacitating injury crashes (\$5.8 million compared to \$400,000).

Each corridor segment is rated on a scale by comparing the segment score with the average statewide score for similar operating environments. Because crash frequencies and rates vary depending on the operating environment of a particular roadway, statewide values were developed for similar operating environments defined by functional classification, urban vs. rural setting,

number of travel lanes, and traffic volumes. For the SR 77 corridor, the following operating environments were identified:

- 2 or 3 lane Undivided Highway: Segments 77-1 and 77-4
- 4 or 5 Lane Undivided Highway: Segments 77-2 and 77-3

### Secondary Safety Measures

Four secondary measures provide an in-depth evaluation of the different characteristics of safety performance:

#### *Directional Safety Index*

- This measure is based on the directional frequency and rate of fatal and incapacitating injury crashes

#### *SHSP Emphasis Areas*

ADOT’s 2014 SHSP identified several emphasis areas for reducing fatal and incapacitating injury crashes. This measure compared rates of crashes in the top five SHSP emphasis areas to other corridors with a similar operating environment. The top five SHSP emphasis areas related to the following driver behaviors:

- Speeding and aggressive driving
- Impaired driving
- Lack of restraint usage
- Lack of motorcycle helmet usage
- Distracted driving

#### *Crash Unit Types*

- The percentage of total fatal and incapacitating injury crashes that involves crash unit types of motorcycles, trucks, or non-motorized travelers is compared to the statewide average on roads with similar operating environments

#### *Safety Hot Spots*

- The hot spot analysis identifies abnormally high concentrations of fatal and incapacitating injury crashes along the study corridor by direction of travel

For the Safety Index and the secondary safety measures, any segment that has too small of a sample size to generate statistically reliable performance ratings for a particular performance measure is considered to have “insufficient data” and is excluded from the safety performance evaluation for that particular performance measure.

### Safety Performance Results

The Safety Index provides a high-level assessment of safety performance for the corridor and for each segment. The four secondary measures provide more detailed information to assess safety performance.

Based on the results of this analysis, the following observations were made:

- Crash unit type performance measures for crashes involving trucks, motorcycles, and non-motorized travelers had insufficient data to generate reliable performance ratings for the SR 77 corridor
- Segments 77-1 and 77-3 had insufficient data to generate reliable performance ratings for crashes involving behaviors associated with the SHSP Top 5 Emphasis Areas, while Segments 77-2 and 77-4 show “below average” performance
- A total of 16 fatal and incapacitating injury crashes occurred along the SR 77 corridor in 2011-2015; of these crashes, 6 were fatal and 10 involved incapacitating injuries
- Safety Index shows “above average” performance for the SR 77 corridor compared to other segments statewide that have similar operating environments, meaning the corridor generally performs well as it relates to safety
- Safety Index value for Segment 77-2 is “below average”, meaning that segments have more crashes than is typical statewide
- Directional Safety Index value for all segments is “above average” except for 77-1 and 77-2 in the NB direction, which is “below average”
- No safety hot spots exist on this corridor

**Table 8** summarizes the Safety performance results for the SR 77 corridor. **Figure 14** illustrates the primary Safety Index performance and locations of Safety hot spots along the SR 77 corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 8: Safety Performance

Segment #	Segment Length (miles)	Total Fatal & Incapacitating Injury Crashes (F/I)	Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers
				NB	SB				
77-1 <sup>c</sup>	5	1/0	1.03	2.05	0.00	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
77-2 <sup>b</sup>	4	2/3	1.83	3.66	0.00	80%	Insufficient Data	Insufficient Data	Insufficient Data
77-3 <sup>b</sup>	14	2/3	0.51	0.56	0.46	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
77-4 <sup>c</sup>	21	1/4	0.41	0.04	0.78	80%	Insufficient Data	Insufficient Data	Insufficient Data
Weighted Corridor Average			0.64	0.76	0.52	36%	Insufficient Data	Insufficient Data	Insufficient Data
SCALES									
Performance Level		2 or 3 or 4 Lane Divided Highway							
Above Average		< 0.77				< 44%	< 4%	< 16%	< 2%
Average		0.77 – 1.23				44% - 54%	4% - 7%	16% - 26%	2% - 4%
Below Average		> 1.23				> 54%	> 7%	> 26%	> 4%
Performance Level		4 or 5 Lane Undivided Highway							
Above Average		< 0.80				< 42%	< 6%	< 6%	< 5%
Average		0.80 – 1.20				42% - 51%	6% - 10%	6% - 9%	5% - 8%
Below Average		> 1.20				> 51%	> 10%	> 9%	> 8%
Performance Level		2 or 3 Lane Undivided Highway							
Above Average		< 0.94				< 51%	< 6%	< 19%	< 5%
Average		0.94 – 1.06				51% - 58%	6% - 10%	19% - 27%	5% - 8%
Below Average		> 1.06				> 58%	> 10%	> 27%	> 8%

<sup>a</sup>2 or 3 or 4 Lane Divided Highway

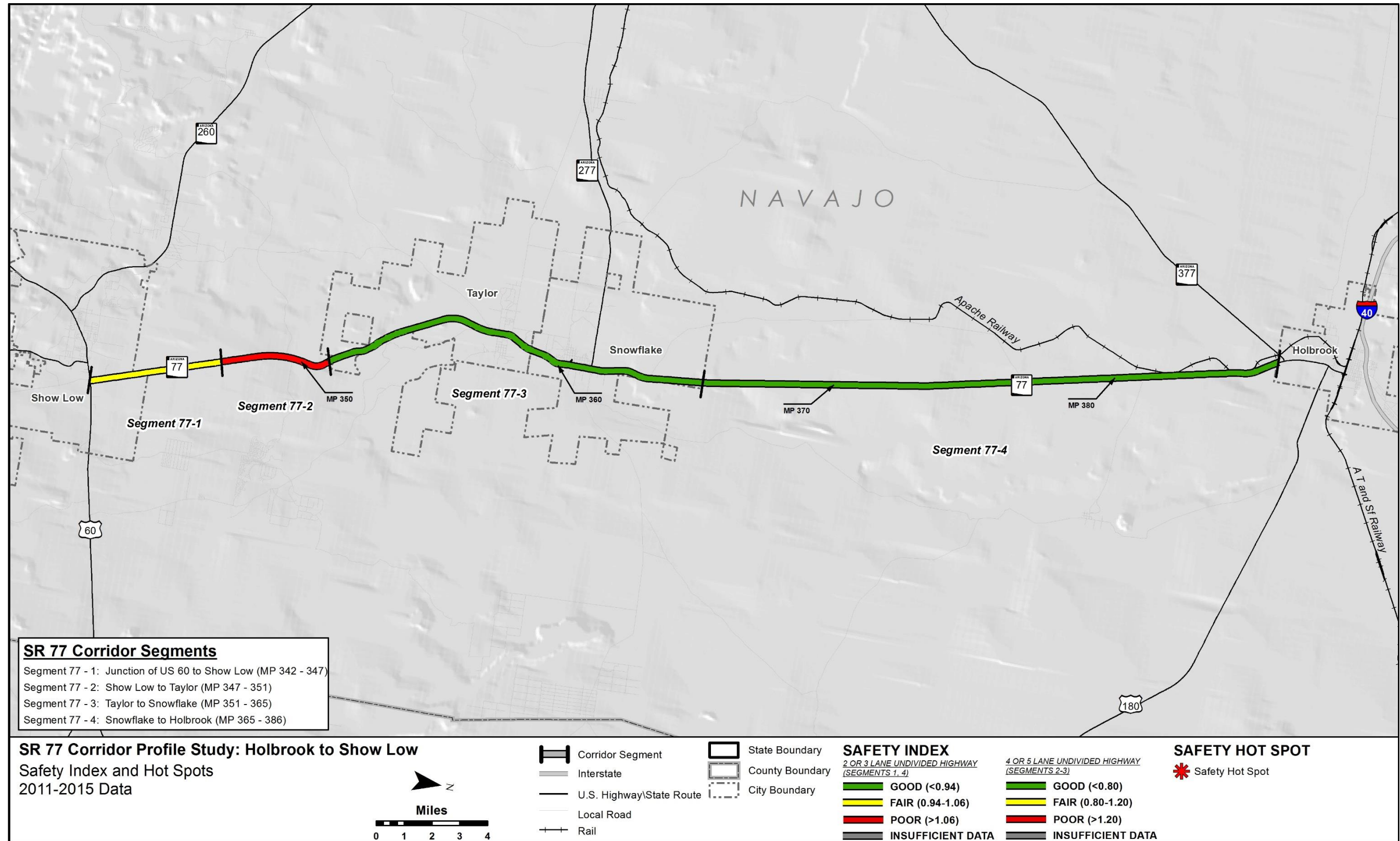
<sup>b</sup>4 or 5 Lane Undivided Highway

<sup>c</sup>2 or 3 Lane Undivided Highway

Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings.



Figure 14: Safety Performance



## 2.6 Freight Performance Area

The Freight performance area consists of a single primary measure (Freight Index) and five secondary measures, as illustrated in **Figure 15**. All measures related to the reliability of truck travel as measured by observed truck travel time speed and delays to truck travel from freeway closures or physical restrictions to truck travel. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

**Figure 15: Freight Performance Measures**



### Primary Freight Index

The Freight Index is a reliability performance measure based on the PTI for truck travel. The Truck Planning Time Index (TPTI) is the ratio of the 95<sup>th</sup> percentile truck travel time to the free-flow truck travel time. The TPTI reflects the extra buffer time needed for on-time delivery while accounting for non-recurring delay. Non-recurring delay refers to unexpected or abnormal delay due to closures or restrictions resulting from circumstances such as crashes, inclement weather, and construction activities.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Freight performance area, the relevant operating environments are interrupted flow (e.g., signalized at-grade intersections are present) and uninterrupted flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway).

For the SR 77 corridor, the following operating environments were identified:

- Uninterrupted Flow: Segments 77-1, 77-2, and 77-4
- Interrupted Flow: Segment 77-3

### Secondary Freight Measures

The Freight performance area includes five secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

#### *Recurring Delay (Directional Truck Travel Time Index [TTTI])*

- The ratio of the average peak period truck travel time to the free-flow truck travel time (based on the posted speed limit up to a maximum of 65 miles per hour) in a given direction
- The TTTI recognizes the delay potential from recurring congestion during peak periods; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics

#### *Non-Recurring Delay (Directional TPTI)*

- The ratio of the 95<sup>th</sup> percentile truck travel time to the free-flow truck travel time (based on the posted speed limit up to a maximum of 65 miles per hour) in a given direction
- The TPTI recognizes the delay potential from non-recurring delays such as traffic crashes, weather, or other incidents; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics
- The TPTI indicates the amount of time in addition to the typical travel time that should be allocated to make an on-time trip 95% of the time in a given direction

#### *Closure Duration*

- The average time (in minutes) a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average is applied to each closure that takes into account the distance over which the closure occurs

#### *Bridge Vertical Clearance*

- The minimum vertical clearance (in feet) over the travel lanes for underpass structures on each segment

#### *Bridge Vertical Clearance Hot Spots*

- A Bridge vertical clearance “hot spot” exists where the underpass vertical clearance over the mainline travel lanes is less than 16.25 feet and no exit/entrance ramps exist to allow vehicles to bypass the low clearance location
- If a location with a vertical clearance less than 16.25 feet can be avoided by using immediately adjacent exit/entrance ramps rather than the mainline, it is not considered a hot spot

### Freight Performance Results

The Freight Index provides a high-level assessment of freight mobility for the corridor and for each segment. The five secondary measures provide more detailed information to assess freight performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Freight Index shows “poor” overall performance for the SR 77 corridor; each of the segments shows either “good” or “poor” performance
- Most segments show either “poor” or “fair” performance for directional TPTI measures, meaning the corridor has “poor” or “fair” travel time reliability due to non-recurring congestion, except for Segment 77-3
- Most segments show either “poor” performance in the closure duration performance measure
- No bridge vertical clearance hot spots exist along the SR 77 corridor

**Table 9** summarizes the Freight performance results for the SR 77 corridor. **Figure 16** illustrates the primary Freight Index performance and locations of freight hot spots along the SR 77 corridor. Maps for each secondary measure can be found in **Appendix A**.

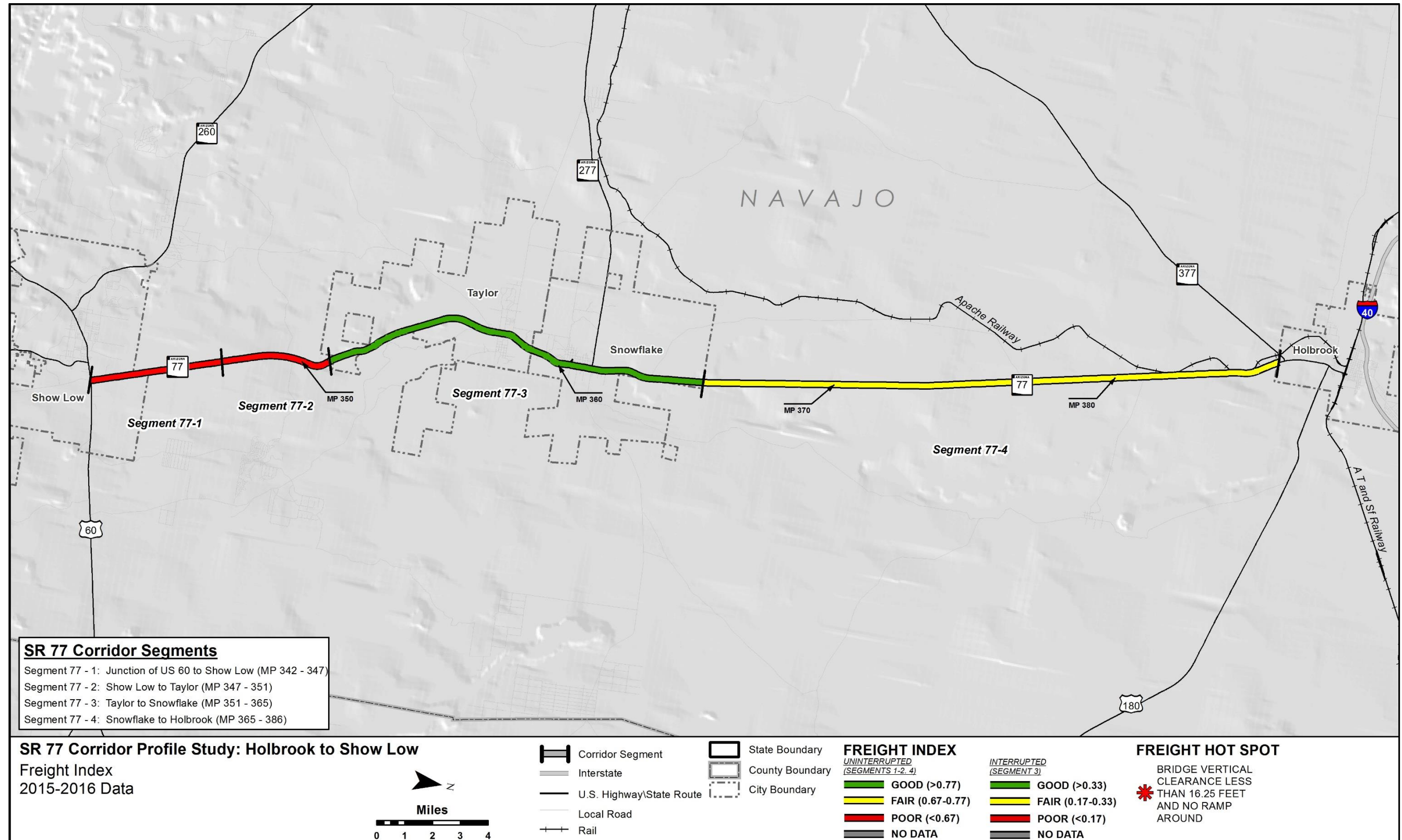
**Table 9: Freight Performance**

Segment #	Segment Length (miles)	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/year/mile)		Bridge Vertical Clearance (feet)
			NB	SB	NB	SB	NB	SB	
77-1 <sup>2^</sup>	5	0.23	1.16	1.11	4.39	4.44	574.65	1164.00	No UP
77-2 <sup>2^</sup>	4	0.44	1.16	1.21	1.22	3.32	608.10	1164.00	No UP
77-3 <sup>2^*</sup>	14	0.57	1.14	1.16	1.67	1.83	503.18	838.90	No UP
77-4 <sup>2^</sup>	21	0.72	1.07	1.09	1.44	1.34	84.80	6.51	No UP
<b>Weighted Corridor Average</b>		0.59	1.11	1.13	1.83	2.03	321.16	508.12	0.0
SCALES									
Performance Level		Uninterrupted Interrupted				All			
Good	> 0.77 <sup>^</sup> > 0.33 <sup>*</sup>	< 1.15 <sup>^</sup> < 1.30 <sup>*</sup>		< 1.30 <sup>^</sup> < 3.00 <sup>*</sup>		< 44.18		> 16.5	
Fair	0.67 - 0.77 <sup>^</sup> 0.17 - 0.33 <sup>*</sup>	1.15 - 1.33 <sup>^</sup> 1.30 - 2.00 <sup>*</sup>		1.30 - 1.50 <sup>^</sup> 3.00-6.00 <sup>*</sup>		44.18 -124.86		16.0 - 16.5	
Poor	< 0.67 <sup>^</sup> < 0.17 <sup>*</sup>	> 1.33 <sup>^</sup> > 2.00 <sup>*</sup>		> 1.50 <sup>^</sup> > 6.00 <sup>*</sup>		> 124.86		< 16.0	

<sup>1</sup>Urban Operating Environment  
<sup>2</sup>Rural Operating Environment  
<sup>^</sup>Uninterrupted Flow Facility  
<sup>\*</sup>Interrupted Flow Facility



Figure 16: Freight Performance



## 2.7 Corridor Performance Summary

Based on the results presented in the preceding sections, the following general observations were made related to the performance of the SR 77 corridor considering the weighted average:

- Pavement Index shows “good” overall performance for the SR 77 corridor
- Bridge Index shows “good” overall performance for the SR 77 corridor
- Mobility Index shows “good” overall performance for the SR 77 corridor
- Safety Index shows “above average” overall performance for the SR 77 corridor
- Freight Index shows “poor” overall performance for the SR 77 corridor
- The lowest performance along the SR 77 corridor generally occurs in the Safety and Freight performance areas with the Pavement, Bridge and Mobility performance areas showing the highest performance

**Figure 17** shows the percentage of the SR 77 corridor that rates either “good/above average” performance, “fair/average” performance, or “poor/below average” performance for each primary measure. On the SR 77 corridor, Freight is the lowest performing area with 20% of the corridor in “poor” condition as it relates to the primary measure. Pavement, Bridge and Mobility are the highest performing areas along the SR 77 corridor with 100% of the corridor in “good” condition as it relates to the primary measures.

**Table 10** shows a summary of corridor performance for all primary measures and secondary measure indicators for the SR 77 corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure. The weighted average ratings are summarized in **Figure 18** which also provides a brief description of each performance measure. **Figure 18** represents the average for the entire corridor and any given segment or location could have a higher or lower rating than the corridor average.

**Figure 17: Performance Summary by Primary Measure**

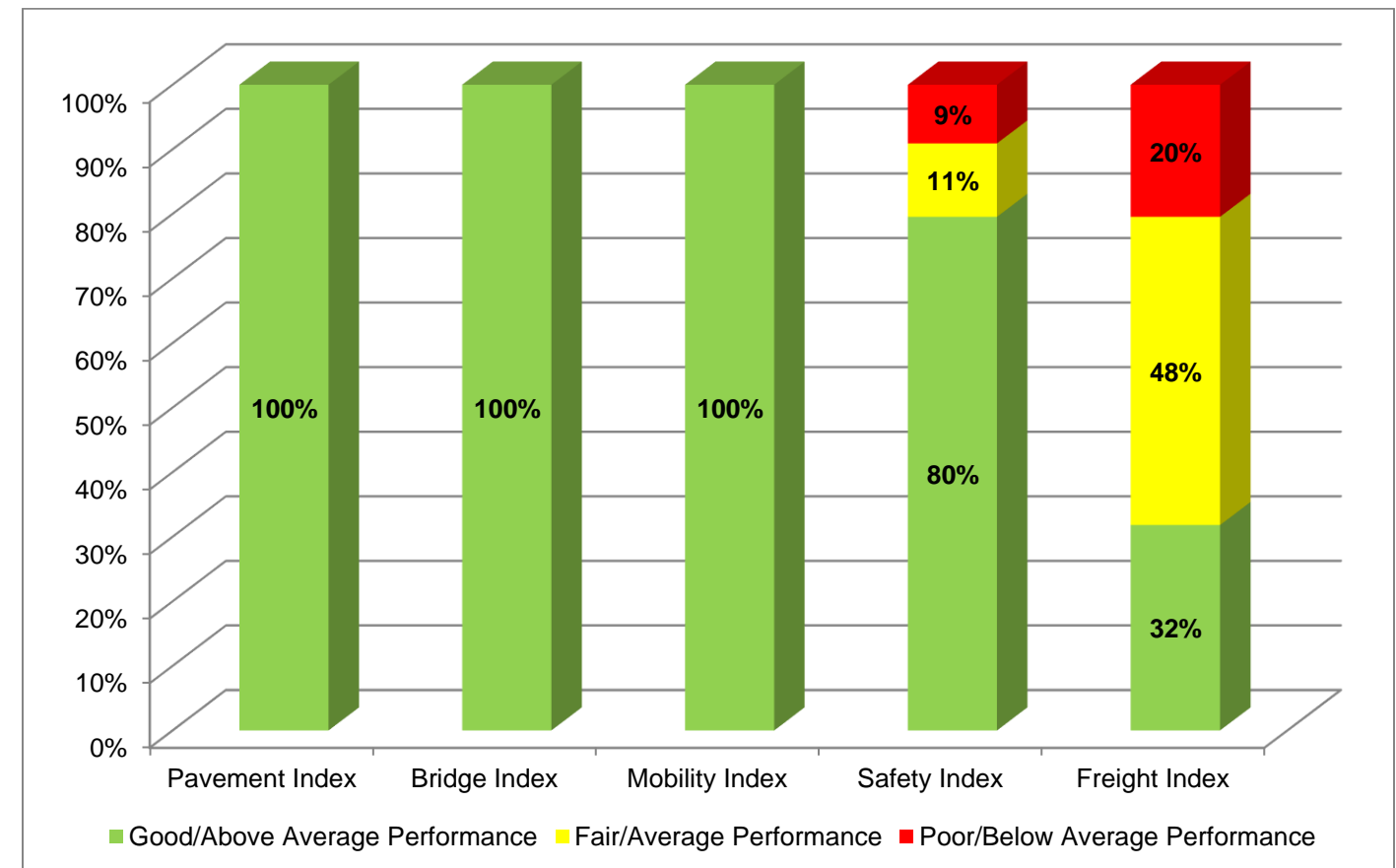




Figure 18: Corridor Performance Summary by Performance Measure

Pavement	Bridge	Mobility	Safety	Freight
<b>Pavement Index (PI):</b> based on two pavement condition ratings from the ADOT Pavement Database; the two ratings are the International Roughness Index (IRI) and the Cracking Rating	<b>Bridge Index (BI):</b> based on four bridge condition ratings from the ADOT Bridge Database; the four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating	<b>Mobility Index (MI):</b> an average of the existing daily volume-to-capacity (V/C) ratio and the projected 2035 daily V/C ratio	<b>Safety Index (SI):</b> combines the bi-directional frequency and rate of fatal and incapacitating injury crashes, compared to crash occurrences on similar roadways in Arizona	<b>Freight Index (FI):</b> a reliability performance measure based on the bi-directional planning time index for truck travel
<ul style="list-style-type: none"> <li>➤ <b>Directional Pavement Serviceability Rating (PSR)</b> – the weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel</li> <li>➤ <b>% Area Failure</b> – the percentage of pavement area rated above failure thresholds for IRI or Cracking</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Sufficiency Rating</b>– multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour</li> <li>➤ <b>% of Deck Area on Functionally Obsolete Bridges</b>– the percentage of deck area in a segment that is on functionally obsolete bridges; identifies bridges that no longer meet standards for current traffic volumes, lane width, shoulder width, or bridge rails; a bridge that is functionally obsolete may still be structurally sound</li> <li>➤ <b>Lowest Bridge Rating</b> –the lowest rating of the four bridge condition ratings on each segment</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Future Daily V/C</b> – the future 2035 V/C ratio provides a measure of future congestion if no capacity improvements are made to the corridor</li> <li>➤ <b>Existing Peak Hour V/C</b> – the existing peak hour V/C ratio for each direction of travel provides a measure of existing peak hour congestion during typical weekdays</li> <li>➤ <b>Closure Extent</b> – the average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel</li> <li>➤ <b>Directional Travel Time Index (TTI)</b> – the ratio of the average peak period travel time to the free-flow travel time; the TTI represents recurring delay along the corridor</li> <li>➤ <b>Directional Planning Time Index (PTI)</b> – the ratio of the 95<sup>th</sup> percentile travel time to the free-flow travel time; the PTI represents non-recurring delay along the corridor</li> <li>➤ <b>% Bicycle Accommodation</b> – the percentage of a segment that accommodates bicycle travel</li> <li>➤ <b>% Non-single Occupancy Vehicle (Non-SOV) Trips</b> –the percentage of trips that are taken by vehicles carrying more than one occupant</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Directional Safety Index</b> – the combination of the directional frequency and rate of fatal and incapacitating injury crashes, compared to crash occurrences on similar roadways in Arizona</li> <li>➤ <b>% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors</b> – the percentage of fatal and incapacitating crashes that involve at least one of the five Strategic Highway Safety Plan (SHSP) emphasis areas on a given segment compared to the statewide average percentage on roads with similar operating environments</li> <li>➤ <b>% of Fatal + Incapacitating Crashes Involving SHSP Crash Unit Types</b> – the percentage of total fatal and incapacitating injury crashes that involves a given crash unit type (motorcycle, truck, non-motorized traveler) compared to the statewide average percentage on roads with similar operating environments</li> </ul>	<ul style="list-style-type: none"> <li>➤ <b>Directional Truck Travel Time Index (TTTI)</b> – the ratio of the average peak period truck travel time to the free-flow truck travel time; the TTTI represents recurring delay along the corridor</li> <li>➤ <b>Directional Truck Planning Time Index (TPTI)</b> – the ratio the 95<sup>th</sup> percentile truck travel time to the free-flow truck travel time; the TPTI represents non-recurring delay along the corridor</li> <li>➤ <b>Closure Duration</b> – the average time a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel</li> <li>➤ <b>Bridge Vertical Clearance</b> – the minimum vertical clearance over the travel lanes for underpass structures on each segment.</li> </ul>

Table 10: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area			Bridge Performance Area				Mobility Performance Area																	
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips					
			NB	SB								NB	SB	NB	SB	NB	SB	NB	SB							
77-1 <sup>2^</sup> ^	5	3.97	3.94		0.0%	No Bridge			0.47	0.55	0.30	0.30	0.43	1.40	1.07	1.04	2.38	2.57	97%	12.9%						
77-2 <sup>2^</sup> ^	4	3.79	3.89		0.0%	No Bridge			0.16	0.18	0.10	0.10	0.50	1.40	1.09	1.14	1.23	2.20	13%	13.6%						
77-3 <sup>2*</sup>	14	4.06	3.72		0.0%	7.00	87.30	0.0%	7	0.48	0.56	0.32	0.32	0.33	1.04	1.09	1.09	1.83	1.80	36%	16.9%					
77-4 <sup>2^</sup> ^	21	3.82	3.81		0.0%	6.74	72.46	48.8%	5	0.13	0.15	0.11	0.10	0.44	0.04	1.01	1.02	1.17	1.22	0%	14.5%					
Weighted Corridor Average		3.91	3.80		0%	6.79	75.43	39%	5.40	0.28	0.33	0.20	0.19	0.41	0.64	1.05	1.06	1.52	1.65	24%	15%					
SCALES																										
Performance Level		Non-Interstate			All				Urban and Fringe Urban				All		Uninterrupted				All							
Good/Above Average		> 3.50			< 5%		> 6.5	> 80	< 12%		> 6		< 0.71				< 0.22		< 1.15		< 1.3		> 90%		> 17%	
Fair/Average		2.90 - 3.50			5% - 20%		5.0 - 6.5	50 - 80	12% - 40%		5 - 6		0.71 - 0.89				0.22 - 0.62		1.15 - 1.33		1.3 - 1.5		60% - 90%		11% - 17%	
Poor/Below Average		< 2.90			> 20%		< 5.0	< 50	> 40%		< 5		> 0.89				> .62		> 1.33		> 1.5		< 60%		< 11%	
Performance Level												Rural						Interrupted								
Good/Above Average												< 0.56						< 1.3		< 3.0						
Fair/Average												0.56 - 0.76						1.3 – 2.0		3.0 – 6.0						
Poor/Below Average												> 0.76						> 2.0		> 6.0						

^Uninterrupted Flow Facility  
\*Interrupted Flow Facility

<sup>a</sup>2 or 3 or 4 Lane Divided Highway  
<sup>b</sup>4 or 5 Lane Undivided Highway

<sup>c</sup>2 or 3 Lane Undivided Highway

<sup>1</sup>Urban Operating Environment  
<sup>2</sup>Rural Operating Environment

Table 10: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area							Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/year/mile)		Bridge Vertical Clearance (feet)
			NB/	SB/						NB	SB	NB	SB			
77-1 <sup>2^</sup> ^	5	1.03	2.05	0.00	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.23	1.16	1.11	4.39	4.44	574.65	1164.00	No UP
77-2 <sup>2^</sup> ^	4	1.83	3.66	0.00	80%	Insufficient Data	Insufficient Data	Insufficient Data	0.44	1.16	1.21	1.22	3.32	608.10	1164.00	No UP
77-3 <sup>2*</sup>	14	0.51	0.56	0.46	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.57	1.14	1.16	1.67	1.83	503.18	838.90	No UP
77-4 <sup>2^</sup> ^	21	0.41	0.04	0.78	80%	Insufficient Data	Insufficient Data	Insufficient Data	0.72	1.07	1.09	1.44	1.34	84.80	6.51	No UP
Weighted Corridor Average		0.64	0.76	0.52	36%	Insufficient Data	Insufficient Data	Insufficient Data	0.59	1.11	1.13	1.83	2.03	321.16	508.12	No UP
SCALES																
Performance Level		2 or 3 or 4 Lane Divided Highway							Uninterrupted				All			
Good/Above Average		< 0.77			< 44%	< 4%	< 16%	< 2%	> 0.77	< 1.15		< 1.3		< 44.18		> 16.5
Fair/Average		0.77 - 1.23			44% - 54%	4% - 7%	16% - 26%	2% - 4%	0.67 - 0.77	1.15 - 1.33		1.3 - 1.5		44.18-124.86		16.0 - 16.5
Poor/Below Average		> 1.23			> 54%	> 7%	> 26%	> 4%	< 0.67	> 1.33		> 1.5		> 124.86		< 16.0
Performance Level		2 or 3 Lane Undivided Highway							Interrupted							
Good/Above Average		< 0.94			< 51%	< 6%	< 19%	< 5%	> 0.33	< 1.3		< 3.0				
Fair/Average		0.94 - 1.06			51% - 58%	6% - 10%	19% - 27%	5% - 8%	0.17 - 0.33	1.3 - 2.0		3.0 - 6.0				
Poor/Below Average		> 1.06			> 58%	> 10%	> 27%	> 8%	< 0.17	> 2.0		> 6.0				
Performance Level		4 or 5 Undivided Highway														
Good/Above Average		< 0.80			< 42%	< 6%	< 6%	< 5%								
Fair/Average		0.80 - 1.20			42% - 51%	6% - 10%	6% - 9%	5% - 8%								
Poor/Below Average		> 1.20			> 51%	> 10%	> 9%	> 8%								

<sup>^</sup>Uninterrupted Flow Facility  
<sup>\*</sup>Interrupted Flow Facility

<sup>^</sup>2 or 3 or 4 Lane Divided Highway  
<sup>^</sup>4 or 5 Lane Undivided Highway

<sup>^</sup>2 or 3 Lane Undivided Highway

<sup>1</sup>Urban Operating Environment  
<sup>2</sup>Rural Operating Environment

Notes: *"Insufficient Data" indicates there was not enough data available to generate reliable performance ratings*  
*"No UP" indicates no underpasses are present in the segment*

### 3.0 NEEDS ASSESSMENT

#### 3.1 Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP), 2010-2035. Statewide performance goals that are relevant to SR 77 performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three “emphasis areas” were identified for the SR 77 corridor: Pavement, Mobility, and Safety.

Considering the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas. **Table 11** shows the SR 77 corridor goals, corridor objectives, and performance objectives, and how they align with the statewide goals.

It is not reasonable within a financially constrained environment to expect that every performance measure will always be at the highest levels on every corridor segment. Therefore, individual corridor segment objectives have been set as “fair/average” or better and should not fall below that standard.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Addressing current and future congestion, thereby improving mobility on congested segments, will also help the corridor fulfill its potential as a significant contributor to the region’s economy.

Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Goal achievement will improve or reduce current and future congestion, increase travel time reliability, and reduce fatalities and incapacitating injuries resulting from vehicle crashes. Where performance is currently rated “good”, the goal is always to maintain that standard, regardless of whether the performance is in an emphasis area.



**Table 11: Corridor Performance Goals and Objectives**

ADOT Statewide LRTP Goals	SR 77 Corridor Goals	SR 77 Corridor Objectives	Performance Area	Primary Measure	Performance Objective	
				Secondary Measure Indicators	Corridor Average	Segment
<b>Improve Mobility, Reliability, and Accessibility</b>  <b>Make Cost Effective Investment Decisions and Support Economic Vitality</b>	Provide a safe, reliable, and efficient connection for the communities along the corridor  Provide a safe and reliable route for recreational and tourist travel  Consider future land use when recommending infrastructure improvements with potential for rural areas to development	Reduce current and future congestion and delay in the urbanized areas  Improve access management and provide guidance for future connections within the corridor  Reduce delays from non-recurring events and incidents to improve reliability  Improve bicycle and pedestrian accommodations  Utilize technology to optimize existing system capacity and performance	Mobility ( <i>Emphasis Area</i> )	Mobility Index	Good	Fair or better
				Future Daily V/C		
				Existing Peak Hour V/C		
				Closure Extent		
				Directional Travel Time Index		
				Directional Planning Time Index		
				% Bicycle Accommodation		
				% Non-SOV Trips		
	Provide a safe, reliable and efficient freight route through the region	Reduce delays and restrictions to freight movement to improve reliability  Improve travel time reliability (including impacts to motorists due to freight traffic)	Freight	Freight Index	Fair or better	Fair or better
				Directional Truck Travel Time Index		
				Directional Truck Planning Time Index		
				Closure Duration		
				Bridge Vertical Clearance		
<b>Preserve and Maintain the System</b>	Preserve and modernize highway infrastructure	Maintain structural integrity of bridges	Bridge	Bridge Index	Fair or better	Fair or better
				Sufficiency Rating		
				% of Deck Area on Functionally Obsolete Bridges		
				Lowest Bridge Rating		
		Improve pavement ride quality for all corridor users	Pavement ( <i>Emphasis Area</i> )	Pavement Index	Good	Fair or better
				Directional Pavement Serviceability Rating		
				% Area Failure		
<b>Enhance Safety</b>	Provide a safe, reliable, and efficient connection for the communities along the corridor  Promote safety by implementing appropriate countermeasures	Reduce fatal and incapacitating injury crashes  Reduce wildlife-related crashes	Safety ( <i>Emphasis Area</i> )	Safety Index	Above Average	Average or better
				Directional Safety Index		
				% of Crashes Involving SHSP Top 5 Emphasis Areas Behaviors		
				% of Crashes Involving Crash Unit Types		

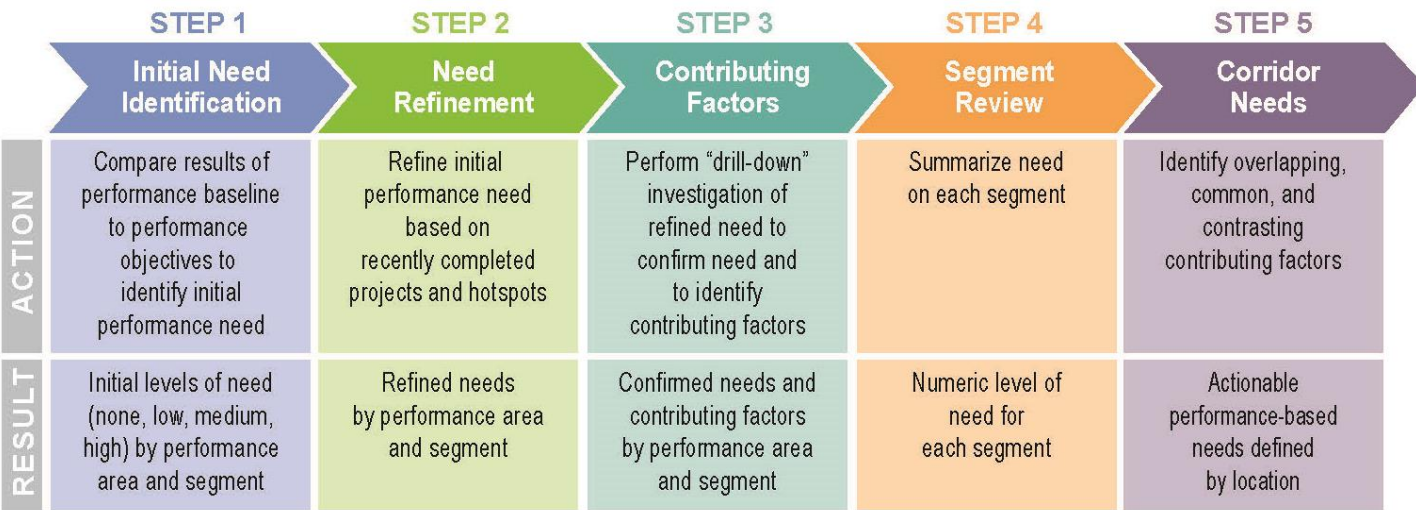
### 3.2 Needs Assessment Process

The following guiding principles were used as an initial step in developing a framework for the performance-based needs assessment process:

- Corridor needs are defined as the difference between the corridor performance and the performance objectives
- The needs assessment process should be systematic, progressive, and repeatable, but also allow for engineering judgment where needed
- The process should consider all primary and secondary performance measures developed for the study
- The process should develop multiple need levels including programmatic needs for the entire length of the corridor, performance area-specific needs, segment-specific needs, and location-specific needs (defined by MP limits)
- The process should produce actionable needs that can be addressed through strategic investments in corridor preservation, modernization, and expansion

The performance-based needs assessment process is illustrated in **Figure 19** and described in the following sections.

**Figure 19: Needs Assessment Process**



#### Step 1: Initial Needs Identification

The first step in the needs assessment process links baseline (existing) corridor performance with performance objectives. In this step, the baseline corridor performance is compared to the performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown below in **Figure 20**.

**Figure 20: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)**

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
5.0	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
	Fair		
	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

*\*A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. Values of 0, 1, 2, and 3 are assigned to the initial need levels of None, Low, Medium, and High, respectively. A weight of 1.0 is applied to the Performance Index need and equal weights of 0.20 are applied to each need for each secondary performance measure. For directional secondary performance measures, each direction of travel receives a weight of 0.10.

#### Step 2: Need Refinement

In Step 2, the initial level of need for each segment is refined using the following information and engineering judgment:

- For segments with an initial need of None that contain hot spots, the level of need should be increased from None to Low
- For segments with an initial level of need where recently completed projects or projects under construction are anticipated to partially or fully address the identified need, the level of need should be reduced or eliminated as appropriate
- Programmed projects that are expected to partially or fully address an identified need are not justification to lower the initial need because the programmed projects may not be implemented as planned; in addition, further investigations may suggest that changes in the scope of a programmed project may be warranted

The resulting final needs are carried forward for further evaluation in Step 3.

#### Step 3: Contributing Factors

In Step 3, a more detailed review of the condition and performance data available from ADOT is conducted to identify contributing factors to the need. Typically, the same databases used to develop the baseline performance serve as the principal sources for the more detailed analysis.

However, other supplemental databases may also be useful sources of information. The databases used for diagnostic analysis are listed below:

Pavement Performance Area

- Pavement Rating Database

Bridge Performance Area

- ABISS

Mobility Performance Area

- Highway Performance Monitoring System (HPMS) Database
- AZTDM
- Real-time traffic conditions data produced by American Digital Cartography Inc. (HERE) Database
- Highway Conditions Reporting System (HCRS) Database

Safety Performance Area

- Crash Database

Freight Performance Area

- HERE Database
- HCRS Database

In addition, other sources considered helpful in identifying contributing factors are:

- Maintenance history (from ADOT PeCoS database for pavement), the level of past investments, or trends in historical data that provide context for pavement and bridge history
- Field observations from ADOT district personnel can be used to provide additional information regarding a need that has been identified
- Previous studies can provide additional information regarding a need that has been identified

Step 3 results in the identification of performance-based needs and contributing factors by segment (and MP locations, if appropriate) that can be addressed through investments in preservation, modernization, and expansion projects to improve corridor performance. See **Appendix D** for more information.

Step 4: Segment Review

In this step, the needs identified in Step 2 and refined in Step 3 are quantified for each segment to numerically estimate the level of need for each segment. Values of 0 to 3 are assigned to the final need levels (from Step 3) of None, Low, Medium, and High, respectively. A weighting factor is applied to the performance areas identified as emphasis areas and a weighted average need is calculated for each segment. The resulting average need score can be used to compare levels of need between segments within a corridor and between segments in different corridors.

Step 5: Corridor Needs

In this step, the needs and contributing factors for each performance area are reviewed on a segment-by-segment basis to identify actionable needs and to facilitate the formation of solution sets that address multiple performance areas and contributing factors. The intent of this process is to identify overlapping, common, and contrasting needs to help develop strategic solutions. This step results in the identification of corridor needs by specific location.

**3.3 Corridor Needs Assessment**

This section documents the results of the needs assessment process described in the prior section. The needs in each performance area were classified as either None, Low, Medium, or High based on how well each segment performed in the existing performance analysis. The needs for each segment were numerically combined to estimate the average level of need for each segment of the corridor

The final needs assessments for each performance measure, along with the scales used in analysis, are shown in **Table 12** through **Table 16**.



Pavement Needs Refinement and Contributing Factors

- Recently completed projects in the corridor did not result in an adjustment to level of need since there was no need
- See **Appendix D** for detailed information on contributing factors

**Table 12: Final Pavement Needs**

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Pavement Index	Directional PSR		% Area Failure				
		NB	SB					
77-1	3.97	3.94	3.94	0%	0.00	None	FY17 H8681: Pavement Preservation, RR 3" AC + CHIP SEAL (MP 342.22-352)	None
77-2	3.79	3.89	3.89	0%	0.00	None	FY17 H8681: Pavement Preservation, RR 3" AC + CHIP SEAL (MP 342.22-352)	None
77-3	4.06	3.72	3.72	0%	0.00	None	FY17 H8681: Pavement Preservation, RR 3" AC + CHIP SEAL (MP 342.22-352) FY17 H8894: Pavement Preservation, ACFC Replacement & Spot Repair (MP 361-373)	None
77-4	3.82	3.81	3.81	0%	0.00	None	FY17 H8894: Pavement Preservation, ACFC Replacement & Spot Repair (MP 361-373)	None
Level of Need (Score)	Performance Score Need Scale				Segment Level Need Scale	<i>*A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.</i>		
None* (0)	> 3.30			< 10%	0			
Low (1)	3.10 - 3.30			10% - 15%	< 1.5			
Medium (2)	2.70 - 3.10			15% - 25%	1.5 - 2.5			
High (3)	< 2.70			> 25%	> 2.5			

*\*A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Bridge Needs Refinement and Contributing Factors

- There are no bridges along the corridor with potential historical investment issues
- One recently completed bridge projects occurred within Segment 77-4, however the other bridges within the segment remain in fair condition. Thus, the level of need for this segment was not adjusted.
- See **Appendix D** for detailed information on contributing factors

**Table 13: Final Bridge Needs**

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Bridge Index	Sufficiency Rating	% of Deck on Functionally Obsolete Bridges	Lowest Bridge Rating				
77-1	No Bridges	No Bridges	No Bridges	No Bridges	None	None	None	None
77-2	No Bridges	No Bridges	No Bridges	No Bridges	None	None	None	None
77-3	7.00	87.30	0.00%	7.00	0.0	None	None	None
77-4	6.74	72.46	48.8%	5.00	0.4	Washboard Wash Bridge (#198)	None	Low
Level of Need (Score)	Performance Score Need Scale				Segment Level Need Scale	<p><i>*A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.</i></p> <p><i># N/A indicates insufficient or no data available to determine level of need</i></p>		
None (0)	> 6.0	> 70	> 5.0	< 21.0%	0			
Low (1)	5.5 - 6.0	60 - 70	5.0	21.0% - 31.0%	< 1.5			
Medium (2)	4.5 - 5.5	40 - 60	4.0	31.0% - 49.0%	1.5 - 2.5			
High (3)	< 4.5	< 40	< 4.0	> 49.0%	> 2.5			

Mobility Needs Refinement and Contributing Factors

- No recently completed mobility projects have occurred along the corridor
- See **Appendix D** for detailed information on contributing factors

**Table 14: Final Mobility Needs**

Segment	Performance Score and Level of Need											Initial Segment Need	Recently Completed Projects	Final Segment Need
	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent		Directional TTI		Directional PTI		% Bicycle Accommodation			
			NB	SB	NB	SB	NB	SB	NB	SB				
77-1	0.47	0.55	0.30	0.30	0.43	1.40	1.07	1.04	2.38	2.57	97%	1.0	None	Low
77-2	0.16	0.18	0.10	0.10	0.50	1.40	1.09	1.14	1.23	2.20	13%	1.4	None	Low
77-3	0.48	0.56	0.32	0.32	0.33	1.04	1.09	1.09	1.83	1.80	36%	0.9	None	Low
77-4	0.13	0.15	0.11	0.10	0.44	0.04	1.01	1.02	1.17	1.22	0%	0.7	None	Low
Level of Need (Score)	Performance Score Need Scale											Segment Level Need Scale	a: Uninterrupted b: Interrupted  *A segment need rating of ‘None’ does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.	
None* (0)	≤ 0.77 (Urban) ≤ 0.63 (Rural)				< 0.35		< 1.21 <sup>a</sup> < 1.53 <sup>b</sup>		< 1.37 <sup>a</sup> < 4.00 <sup>b</sup>		> 80%	0		
Low (1)	0.77 - 0.83 (Urban) 0.63 - 0.69 (Rural)				0.35 - 0.49		1.21 - 1.27 <sup>a</sup> 1.53 - 1.77 <sup>b</sup>		1.37 - 1.43 <sup>a</sup> 4.00 - 5.00 <sup>b</sup>		70% - 80%	< 1.5		
Medium (2)	0.83 - 0.95 (Urban) 0.69 - 0.83 (Rural)				0.49 - 0.75		1.27 - 1.39 <sup>a</sup> 1.77 - 2.23 <sup>b</sup>		1.43 - 1.57 <sup>a</sup> 5.00 - 7.00 <sup>b</sup>		50% - 70%	1.5 - 2.5		
High (3)	≥ 0.95 (Urban) ≥ 0.83 (Rural)				> 0.75		> 1.39 <sup>a</sup> > 2.23 <sup>b</sup>		> 1.57 <sup>a</sup> > 7.00 <sup>b</sup>		< 50%	> 2.5		



Safety Needs Refinements and Contributing Factors

- No adjustments were made between the initial and final needs
- No recently completed safety projects have occurred along the corridor
- See **Appendix D** for detailed information on contributing factors

**Table 15: Final Safety Needs**

Segment		Performance Score and Level of Need						Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need	
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Area Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles					% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers
			NB	SB								
77-1		1.03	2.05	0.00	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	2.3	-	None	Medium
77-2		1.83	3.66	0.00	0.80	Insufficient Data	Insufficient Data	Insufficient Data	3.9	-	None	High
77-3		0.51	0.56	0.46	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	-	None	None
77-4		0.41	0.04	0.78	0.80	Insufficient Data	Insufficient Data	Insufficient Data	0.6	-	None	Low
Level of Need (Score)		Performance Score Needs Scale							Segment Level Need Scale	a: 2 or 3 or 4 Lane Divided Highway b: 4 or 5 Lane Undivided Highway c: 2 or 3 Lane Undivided Highway  *A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.		
None* (0)	a	≤ 0.92			≤ 47%	≤ 5%	≤ 19%	≤ 3%	0			
	b	≤ 0.93			≤ 45%	≤ 7%	≤ 7%	≤ 6%				
	c	≤ 0.98			≤ 53%	≤ 6%	≤ 22%	≤ 3%				
Low (1)	a	0.92 - 1.07			47% - 50%	5% - 6%	19% - 22%	3% - 4%	≤ 1.5			
	b	0.93 - 1.06			45% - 48%	7% - 8%	7% - 8%	6% - 7%				
	c	0.98 - 1.02			53% - 55%	6% - 7%	22% - 25%	3% - 4%				
Medium (2)	a	1.07 - 1.38			50% - 57%	6% - 8%	22% - 29%	4% - 5%	1.5 - 2.5			
	b	1.06 - 1.33			48% - 54%	8% - 11%	8% - 10%	7% - 9%				
	c	1.02 - 1.10			55% - 59%	7% - 8%	25% - 30%	4% - 5%				
High (3)	a	≥ 1.38			≥ 57%	≥ 8%	≥ 29%	≥ 5%	≥ 2.5			
	b	≥ 1.33			≥ 54%	≥ 11%	≥ 10%	≥ 9%				
	c	≥ 1.10			≥ 59%	≥ 8%	≥ 30%	≥ 5%				

Freight Needs Refinements and Contributing Factors

- No adjustments were made between the initial and final needs
- See **Appendix D** for detailed information on contributing factors

**Table 16: Final Freight Needs**

Segment		Performance Score and Level of Need							Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need		
		Freight Index	Directional TTTI		Directional TPTI		Closure Duration						Bridge Vertical Clearance	
			NB	SB	NB	SB	NB	SB						
77-1		0.23	1.16	1.11	4.39	4.44	574.65	1164.00	No UP	4.2	-	None	High	
77-2		0.44	1.16	1.21	1.22	3.32	608.10	1164.00	No UP	4.0	-	None	High	
77-3		0.57	1.14	1.16	1.67	1.83	503.18	838.90	No UP	0.6	-	None	Low	
77-4		0.72	1.07	1.09	1.44	1.34	84.80	6.51	No UP	1.3	-	None	Low	
Level of Need (Score)		Performance Score Need Scale							Segment Level Need Scale		a: Uninterrupted Flow b: Interrupted Flow  *A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.			
None* (0)	a b	≥ 0.74 ≥ 0.28	≤ 1.21 ≤ 1.53		≤ 1.37 ≤ 4.00		≤ 71.07		≥ 16.33					0
Low (1)	a b	0.70 - 0.74 0.22 – 0.28	1.21 - 1.27 1.53 - 1.77		1.37 - 1.43 4.00 - 5.00		71.07 - 97.97		16.17 - 16.33					≤ 1.5
Medium (2)	a b	0.64 - 0.70 0.12 – 0.22	1.27 - 1.39 1.77 - 2.23		1.43 - 1.57 5.00 - 7.00		97.97 - 151.75		15.83 - 16.17					1.5 - 2.5
High (3)	a b	≤ 0.64 ≤ 0.12	≥ 1.39 ≥ 2.23		≥ 1.57 ≥ 7.00		≥ 151.75		≤ 15.83					≥ 2.5

Segment Review

The needs for each segment were combined to numerically estimate the average level of need for each segment of the corridor. **Table 17** provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Pavement, Mobility, and Safety for the SR 77 corridor). Three of the four segments have a Medium average need, and the remaining segment has a Low average need.

**Table 17: Summary of Needs by Segment**

Performance Area	77-1	77-2	77-3	77-4
	MP 342-347	MP 347-351	MP 351-365	MP 365-386
Pavement+	None*	None*	None*	None*
Bridge	None*	None*	None*	Low
Mobility+	Low	Low	Low	Low
Safety+	Medium	High	None*	Low
Freight	High	High	Low	Low
Average Need	1.15	1.38	0.38	0.77

\* A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.

+ Identified as an emphasis area for the SR 77 corridor.

Average Need Scale	
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0



### Summary of Corridor

The needs in each performance area are shown in **Figure 21** and summarized below:

#### *Pavement Needs*

- None of the segments have Pavement needs

#### *Bridge Needs*

- Segments 77-1 and 77-2 do not include any bridges
- Segment 77-3 has no Bridge needs and Segment 77-4 has a low final Bridge need

#### *Mobility Needs*

- Low Mobility needs exist on all four segments of the corridor
- Many segments contain Medium or High directional PTI needs
- Bicycle accommodation needs are High on Segments 77-2, 77-3, and 77-4

#### *Safety Needs*

- High Safety needs exist on Segment 77-2, Medium on Segment 77-1 and Low on Segment 77-4
- No Safety needs register on Segment 77-3
- Many of the segments of the corridor contain insufficient data to determine levels of need for the top 5 emphasis areas, so a need value is not available (N/A)

#### *Freight Needs*

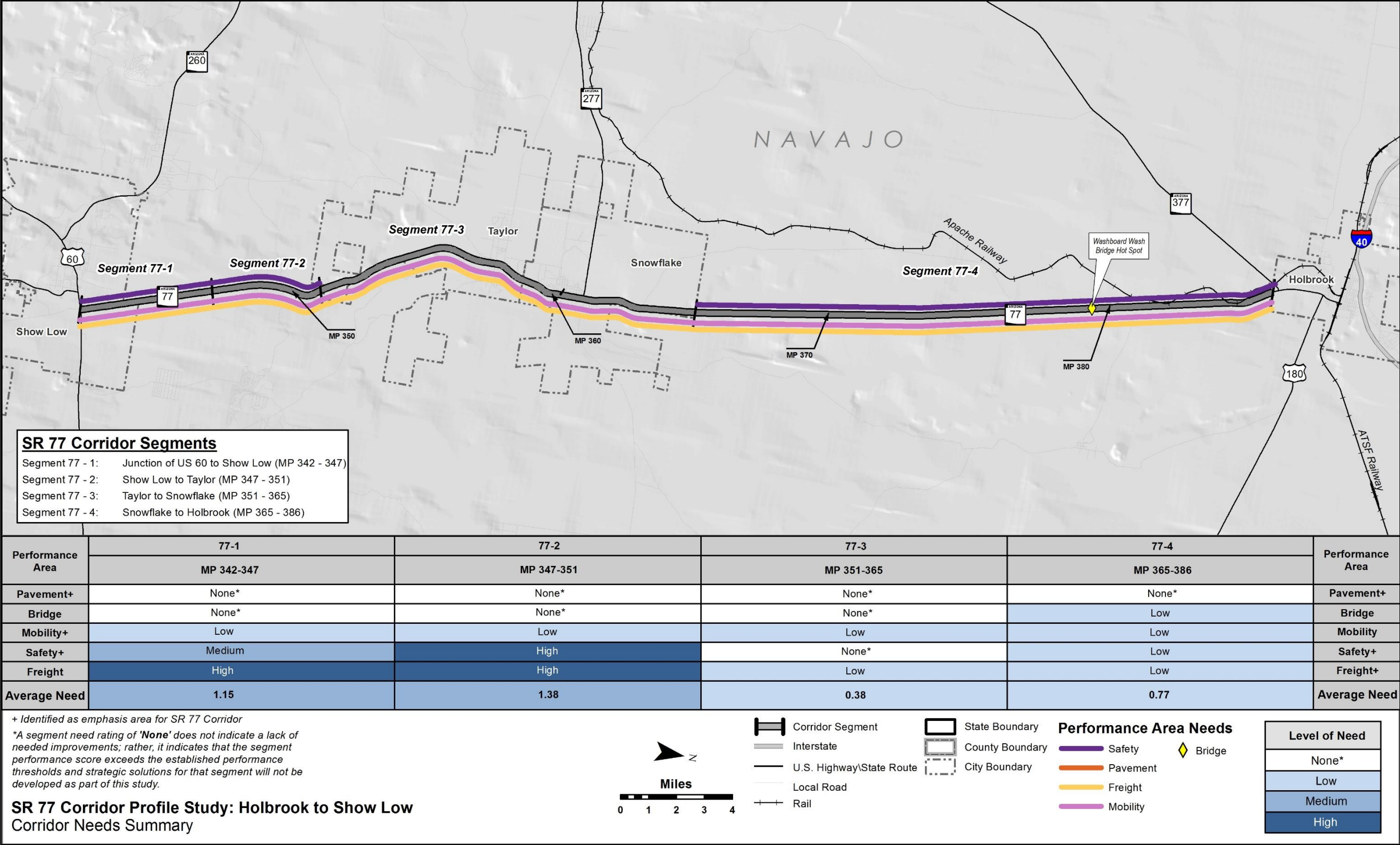
- High Freight needs exist on two of the four segments
- Many segments along the corridor contain High directional PTI and closure duration needs
- No freight hot spots exist along the corridor

### Overlapping Needs

This section identifies overlapping performance needs on the SR 77 corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- Segments 77-1 and 77-2 contain elevated Needs in the Safety and Freight performance areas
- Segment 77-2 has the highest average need score of all the segments of the corridor
- All segments have some level of need

Figure 21 Corridor Needs Summary



## Appendix A: Corridor Performance Maps

This appendix contains maps of each primary and secondary measure associated with the five performance areas for the SR 77 corridor. The following are the areas and maps included:

Pavement Performance Area:

- Pavement Index and Hot Spots
- Pavement Serviceability (directional)
- Percentage of Pavement Area Failure

Bridge Performance Area:

- Bridge Index and Hot Spots
- Bridge Sufficiency
- Percent of Deck Area on Functionally Obsolete Bridges
- Lowest Bridge Rating

Mobility Performance Area:

- Mobility Index
- Future Daily V/C
- Existing Peak V/C (directional)
- Average Instances Per Year a Given Milepost is Closed Per Segment Mile
- All Vehicles Travel Time Index
- All Vehicles Planning Time Index
- Multimodal Opportunities
- Percentage of Bicycle Accommodation

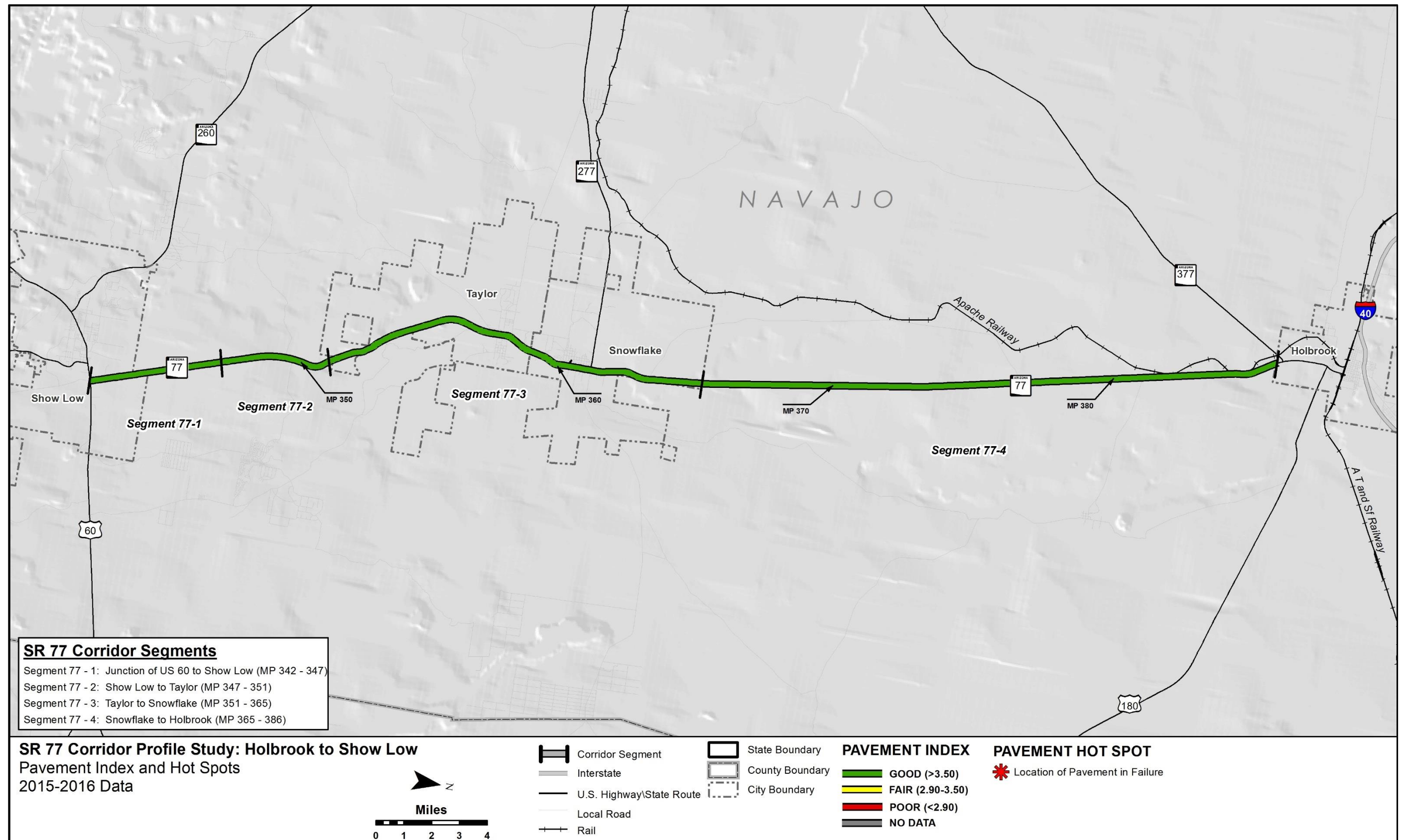
Safety Performance Area:

- Safety Index and Hot Spots
- Safety Index and Hot Spots (directional)
- Relative Frequency of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors Compared to the Statewide Average for Similar Segments
- Relative Frequency of Fatal + Incapacitating Injury Crashes Involving Motorcycles Compared to the Statewide Average for Similar Segments

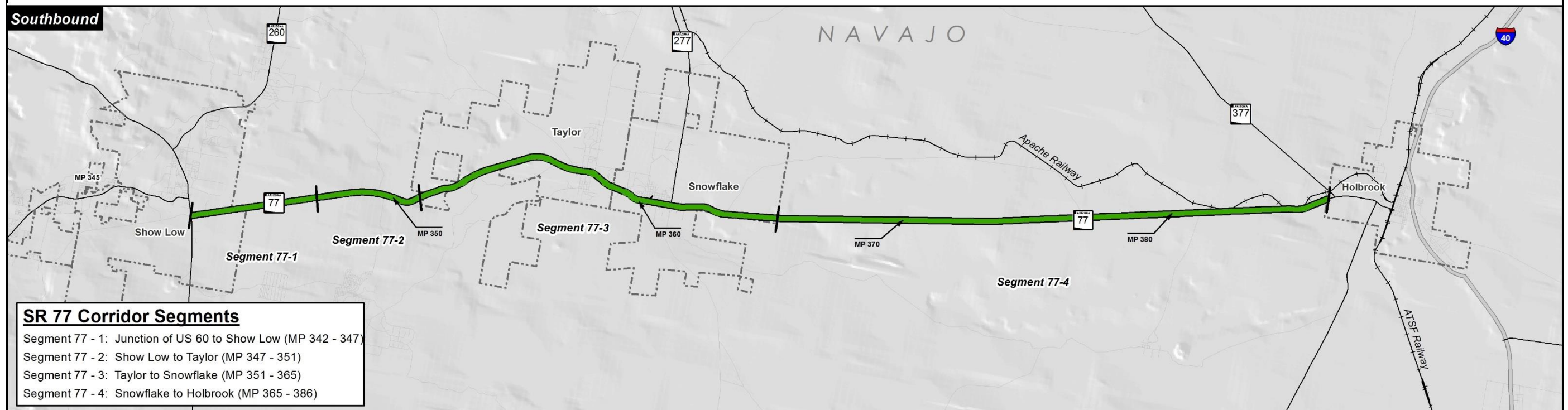
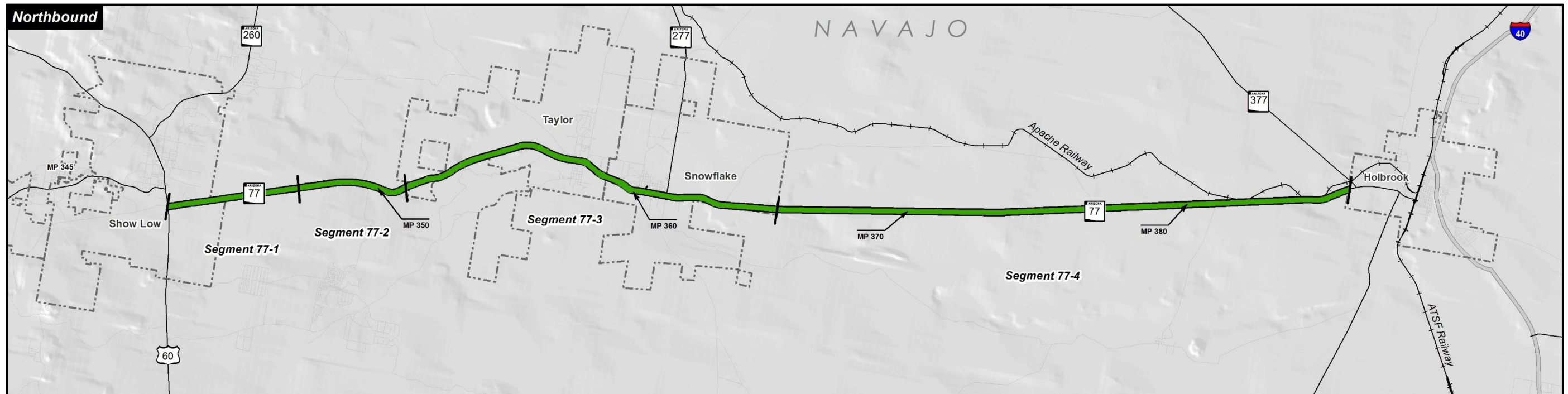
Freight Performance Area:

- Freight Index and Hot Spots
- Truck Travel Time Index
- Truck Planning Time Index
- Average Minutes Per Year Given Milepost is Closed Per Segment Mile
- Bridge Vertical Clearance





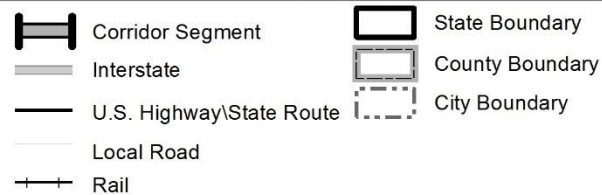
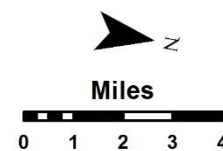




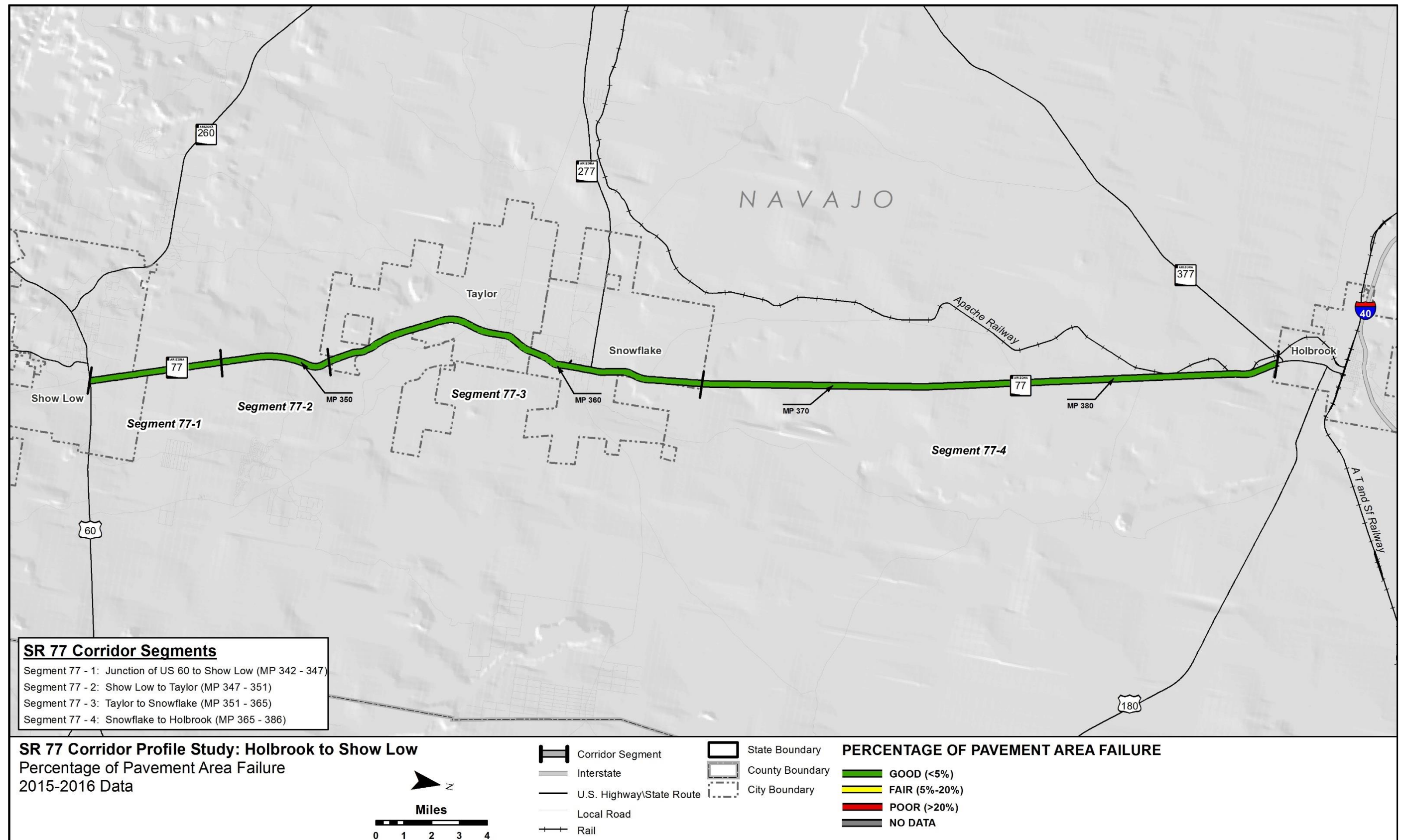
#### SR 77 Corridor Segments

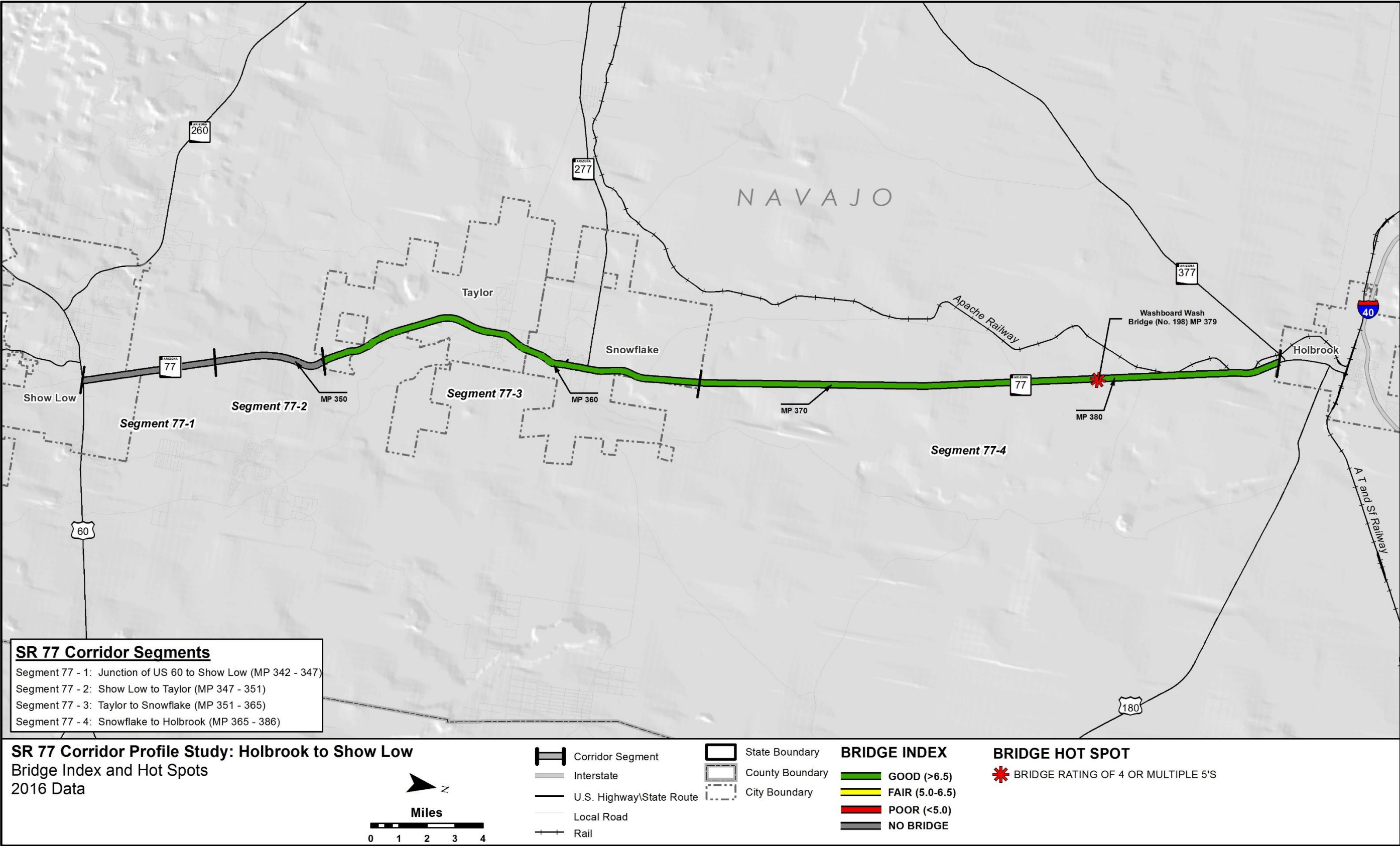
Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
 Segment 77 - 2: Show Low to Taylor (MP 347 - 351)  
 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

#### SR 77 Corridor Profile Study: Holbrook to Show Low Pavement Serviceability Index and Hot Spots 2015-2016 Data

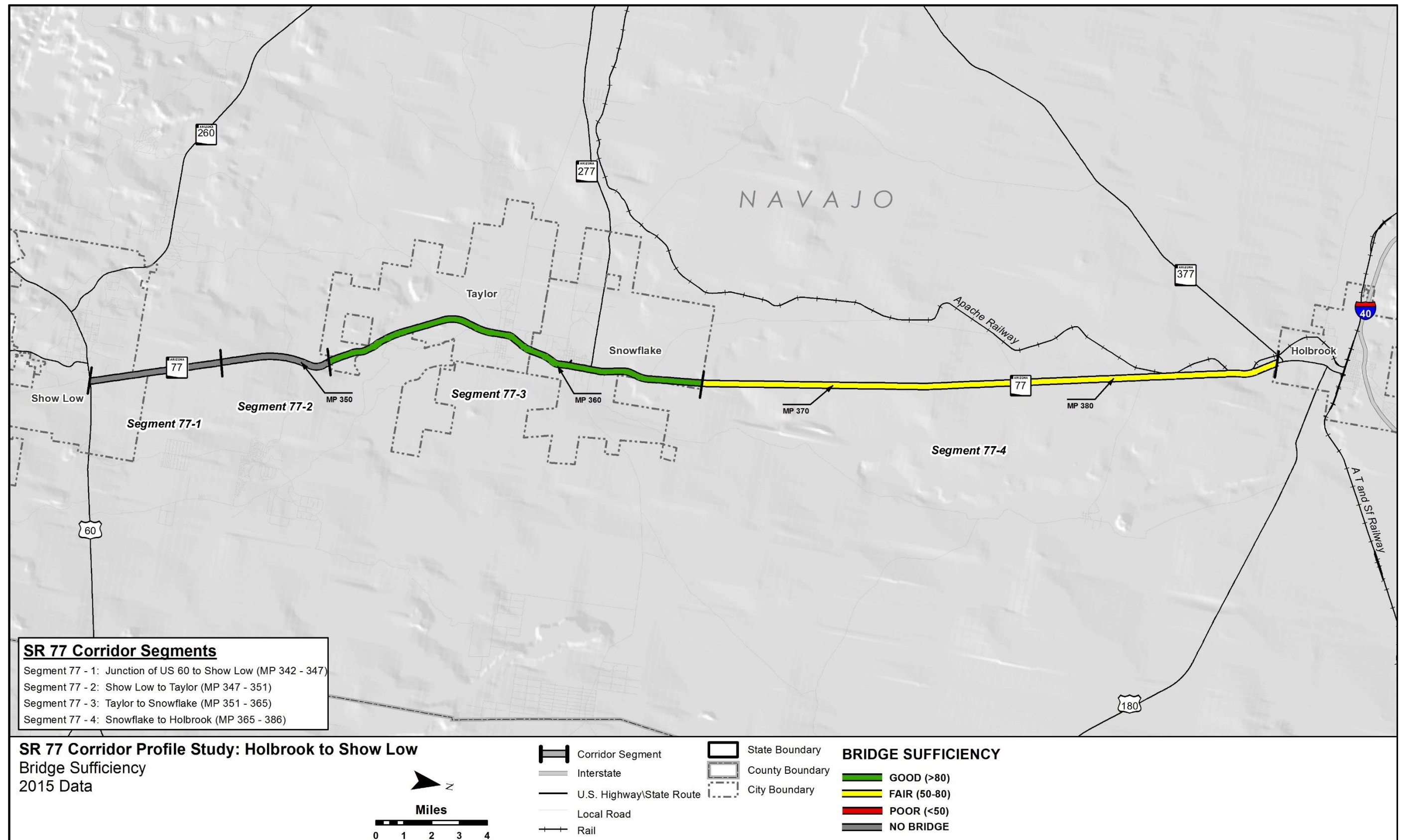


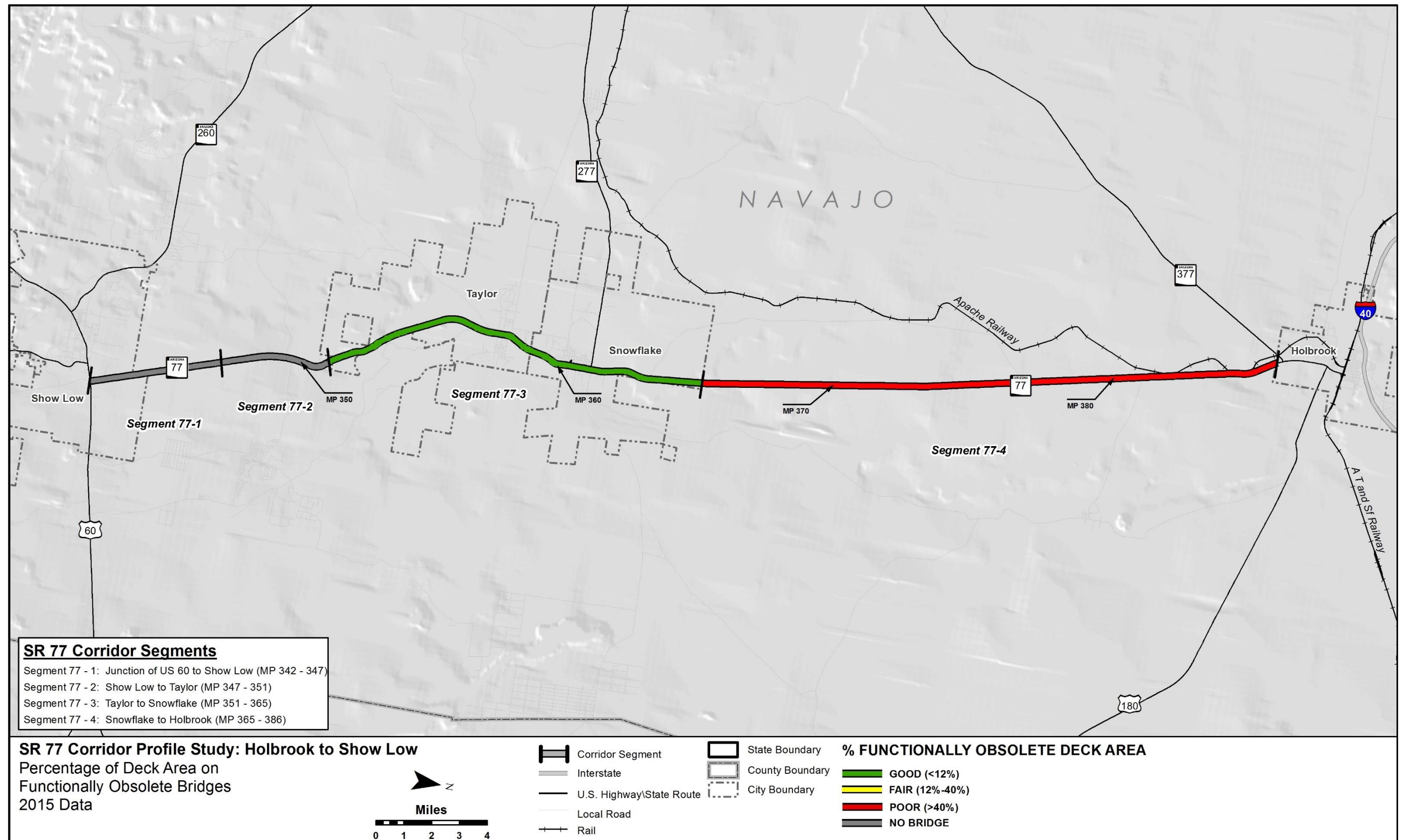




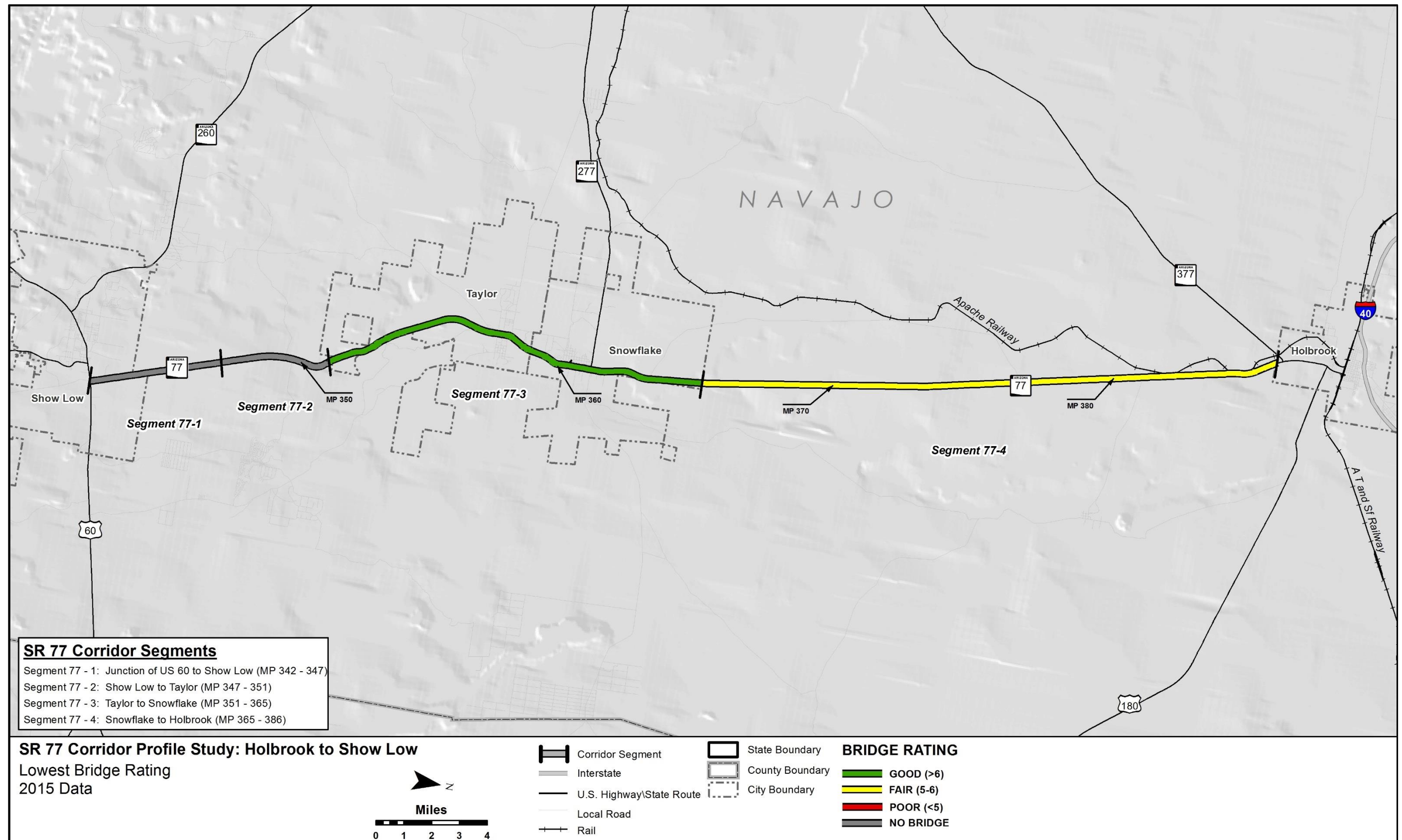


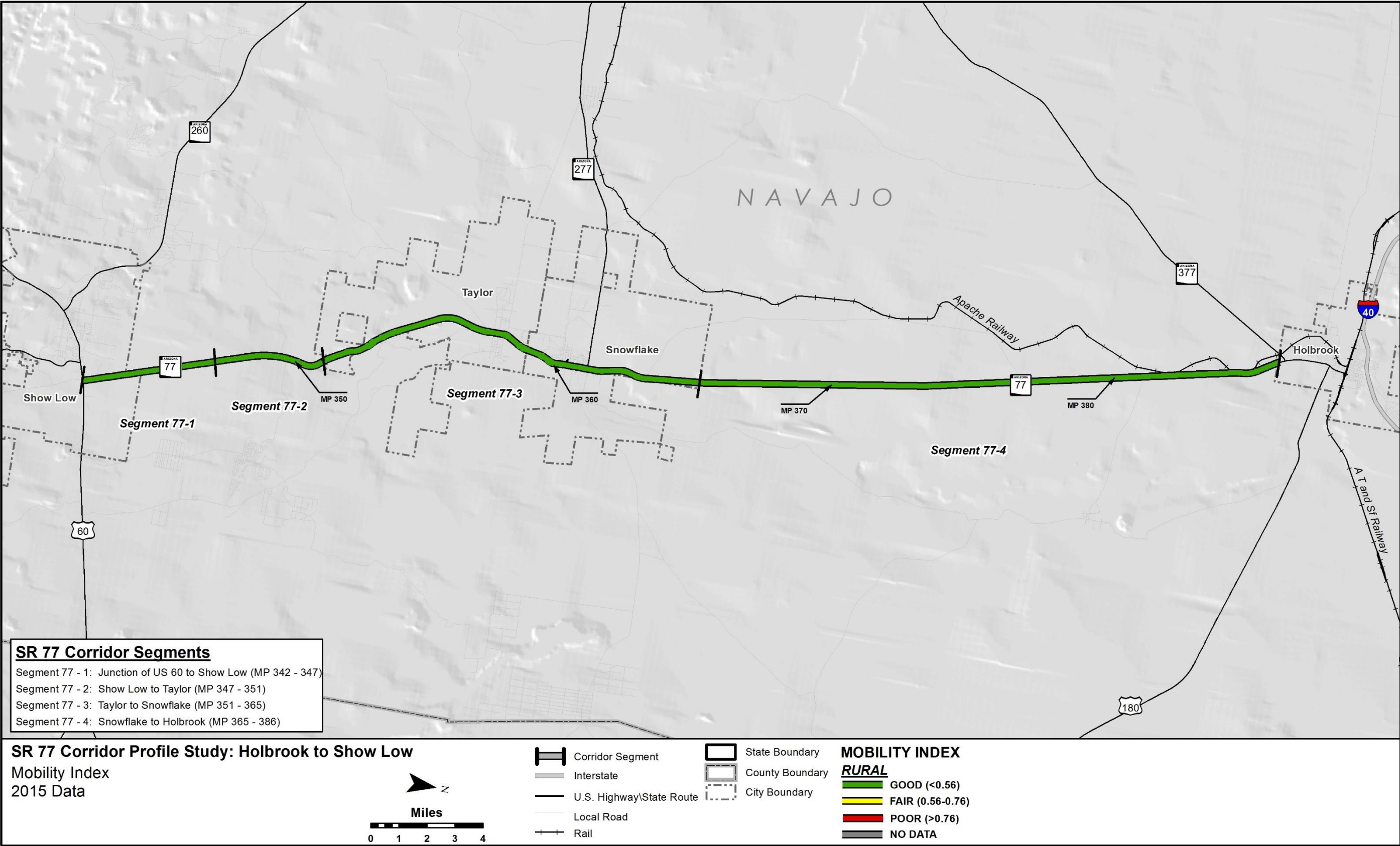




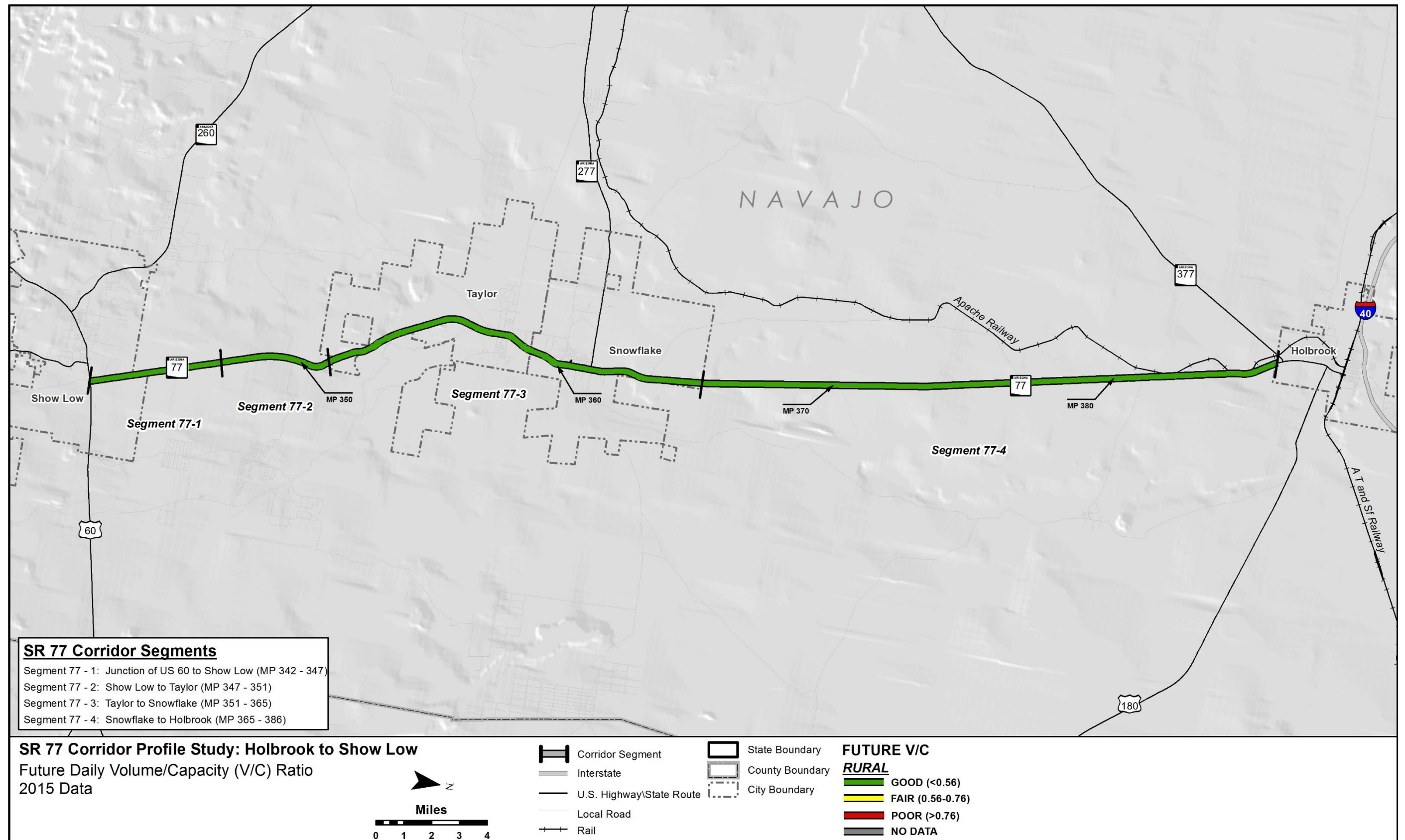


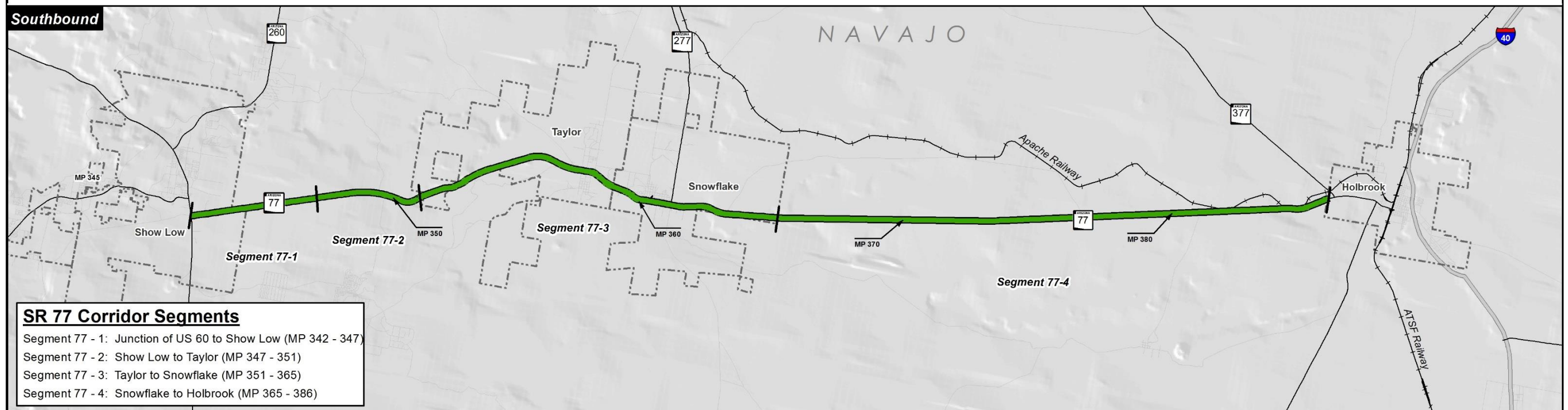
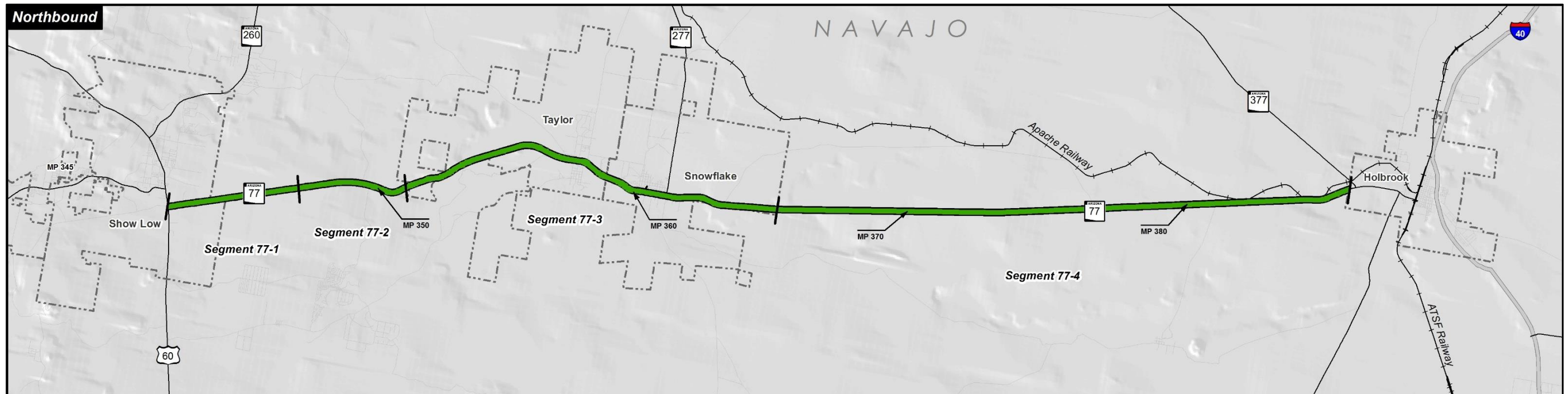










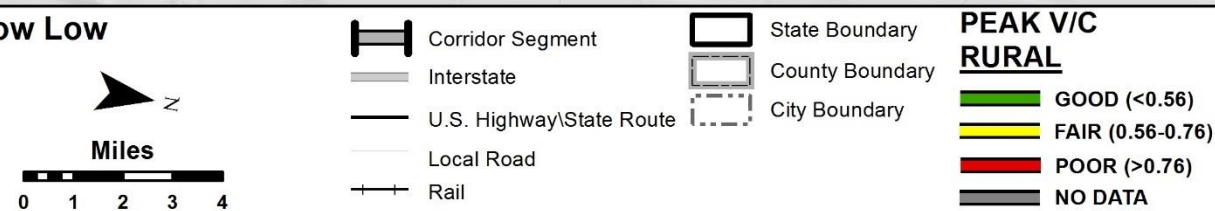


**SR 77 Corridor Segments**

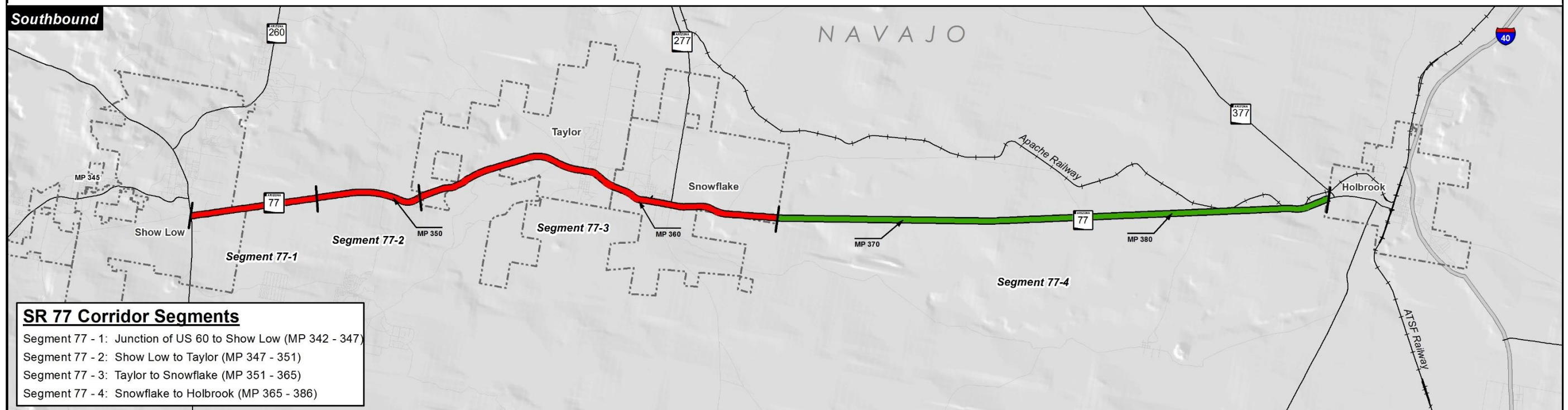
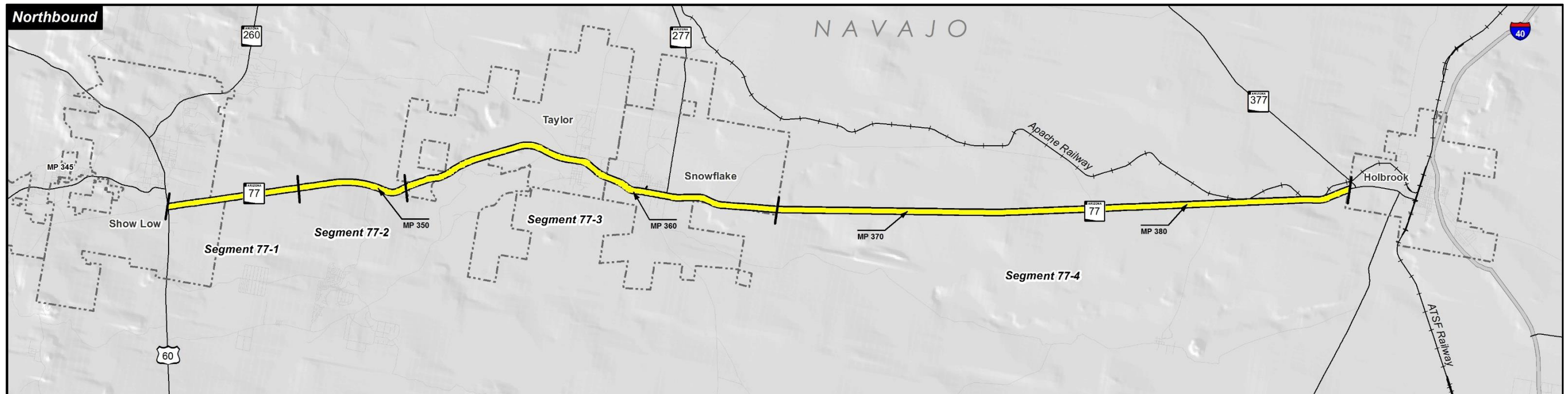
Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
 Segment 77 - 2: Show Low to Taylor (MP 347 - 351)  
 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

**SR 77 Corridor Profile Study: Holbrook to Show Low**

Existing Peak Hour V/C  
 2015 Data





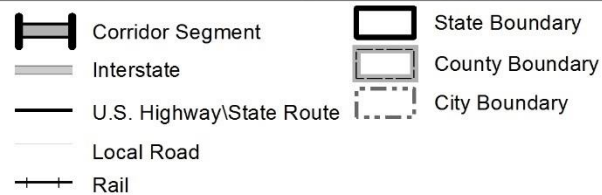
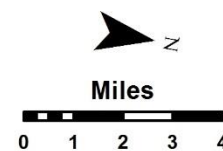


**SR 77 Corridor Segments**

Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
 Segment 77 - 2: Show Low to Taylor (MP 347 - 351)  
 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

**SR 77 Corridor Profile Study: Holbrook to Show Low**

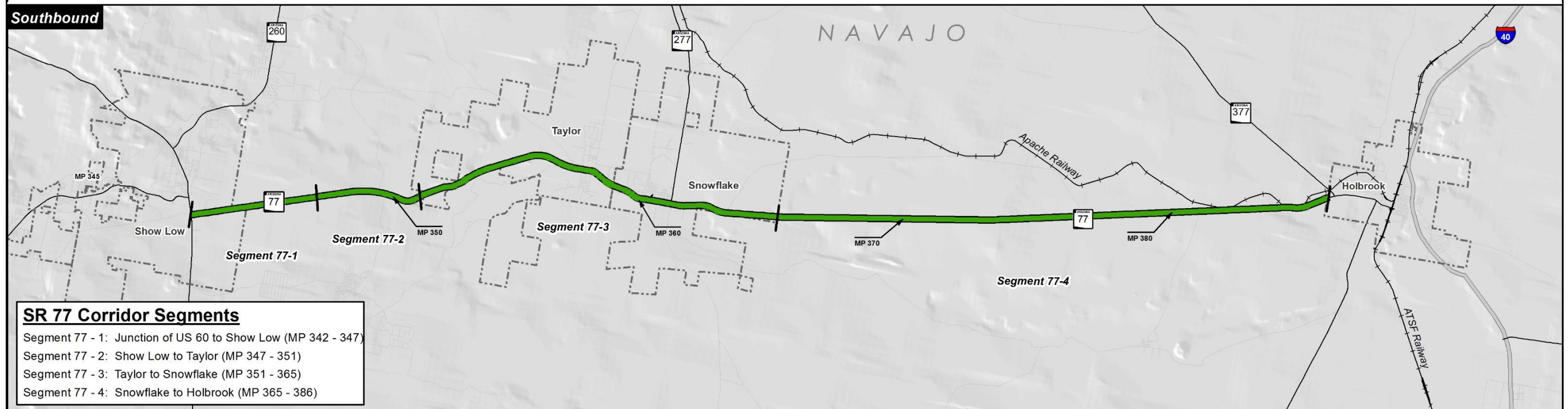
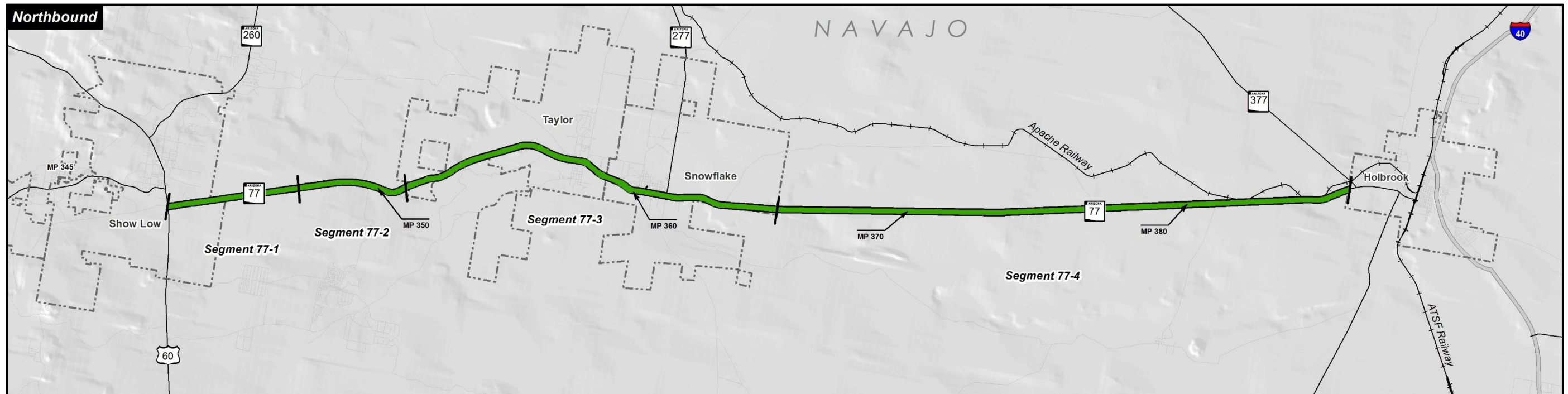
Average Instances Per Year A  
 Given Milepost Is Closed Per  
 Segment Mile  
 2015 Data



**CLOSURES PER MILE PER YEAR**





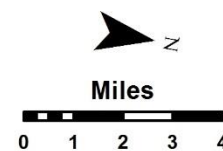


**SR 77 Corridor Segments**

Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
 Segment 77 - 2: Show Low to Taylor (MP 347 - 351)  
 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

**SR 77 Corridor Profile Study: Holbrook to Show Low**

All Vehicles Travel Time Index  
 2015 Data

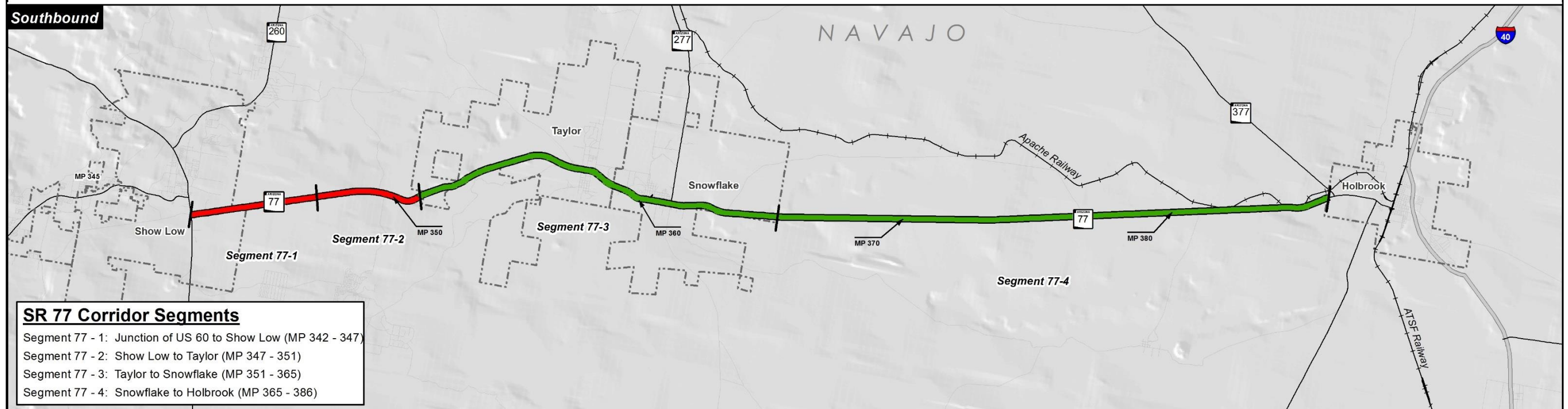
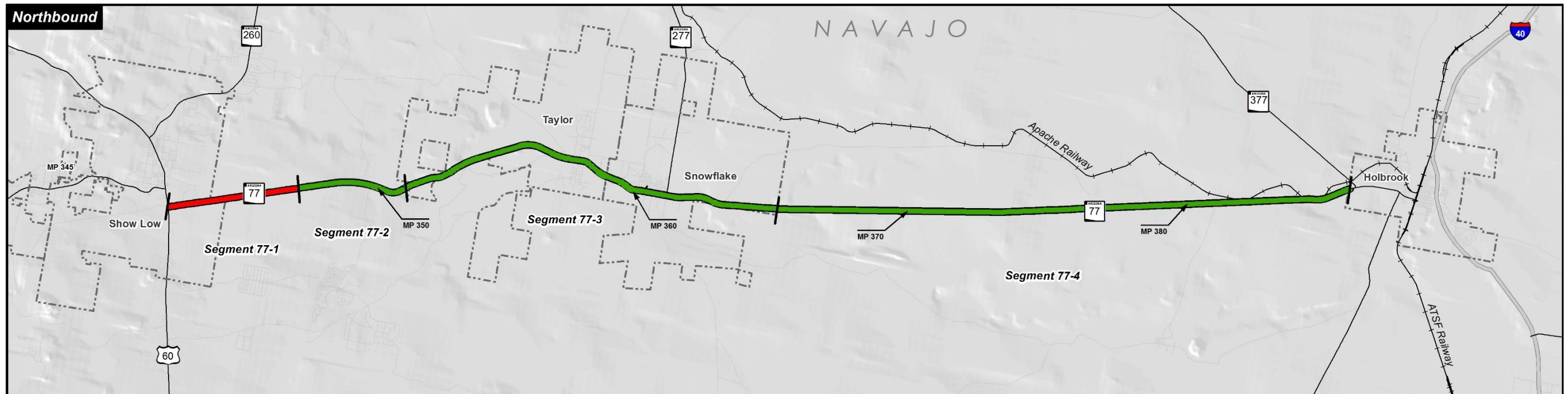


- Corridor Segment
- Interstate
- U.S. Highway/State Route
- Local Road
- Rail
- State Boundary
- County Boundary
- City Boundary

**ALL VEHICLES TRAVEL TIME INDEX**

UNINTERRUPTED (SEGMENTS 1-2, 4)	INTERRUPTED (SEGMENT 3)
GOOD (<1.15)	GOOD (<1.3)
FAIR (1.15-1.33)	FAIR (1.3-2.0)
POOR (>1.33)	POOR (>2.0)
NO DATA	NO DATA



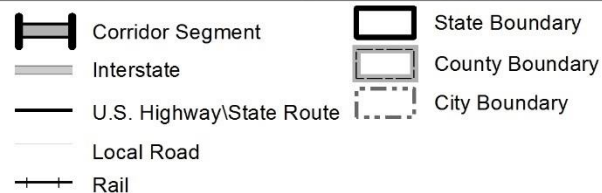
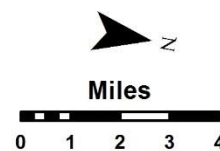


**SR 77 Corridor Segments**

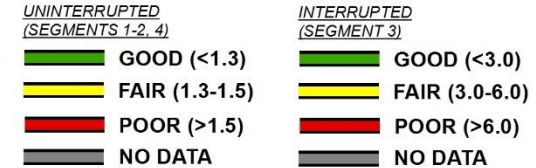
Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
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 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

**SR 77 Corridor Profile Study: Holbrook to Show Low**

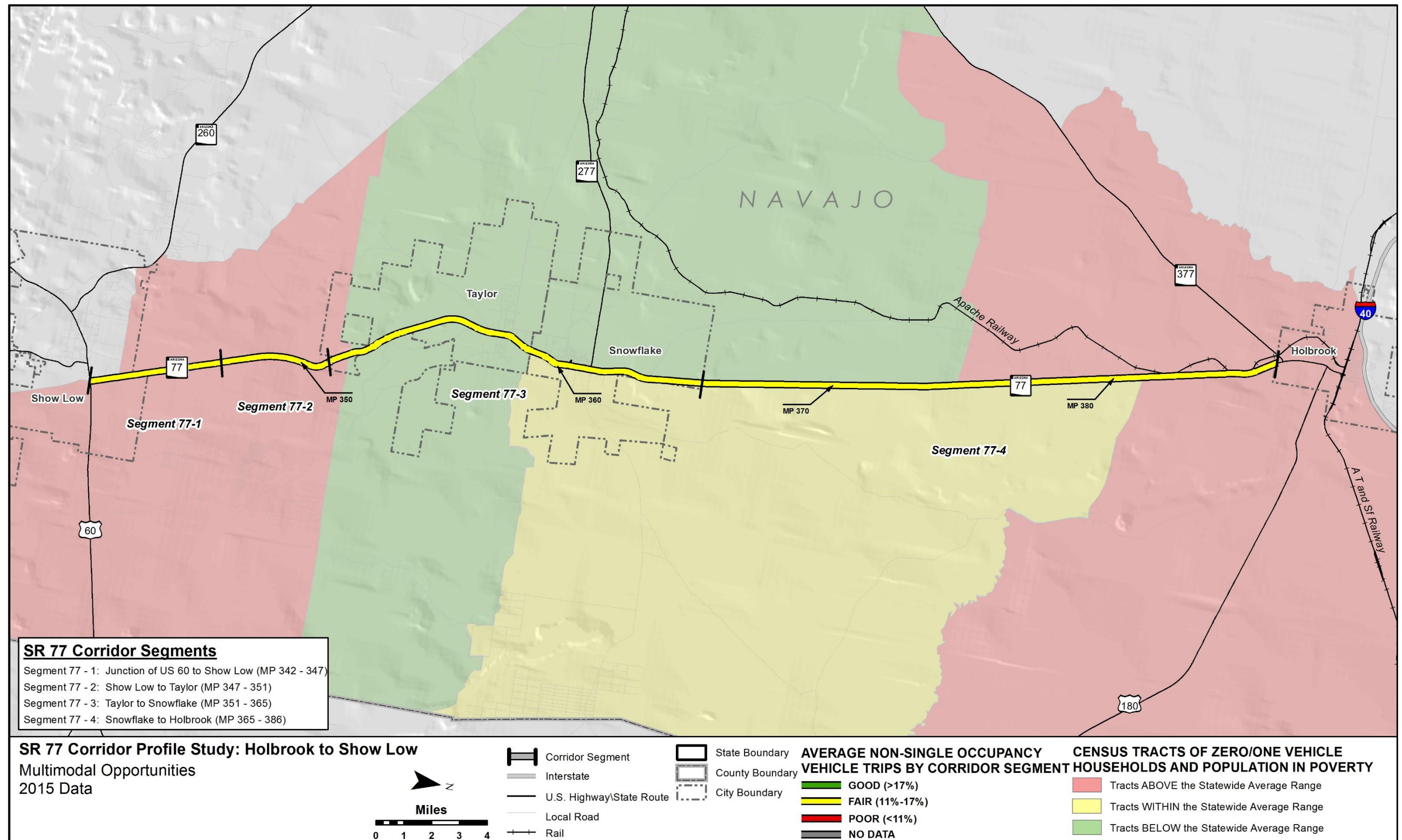
All Vehicles Planning Time Index  
 2015 Data

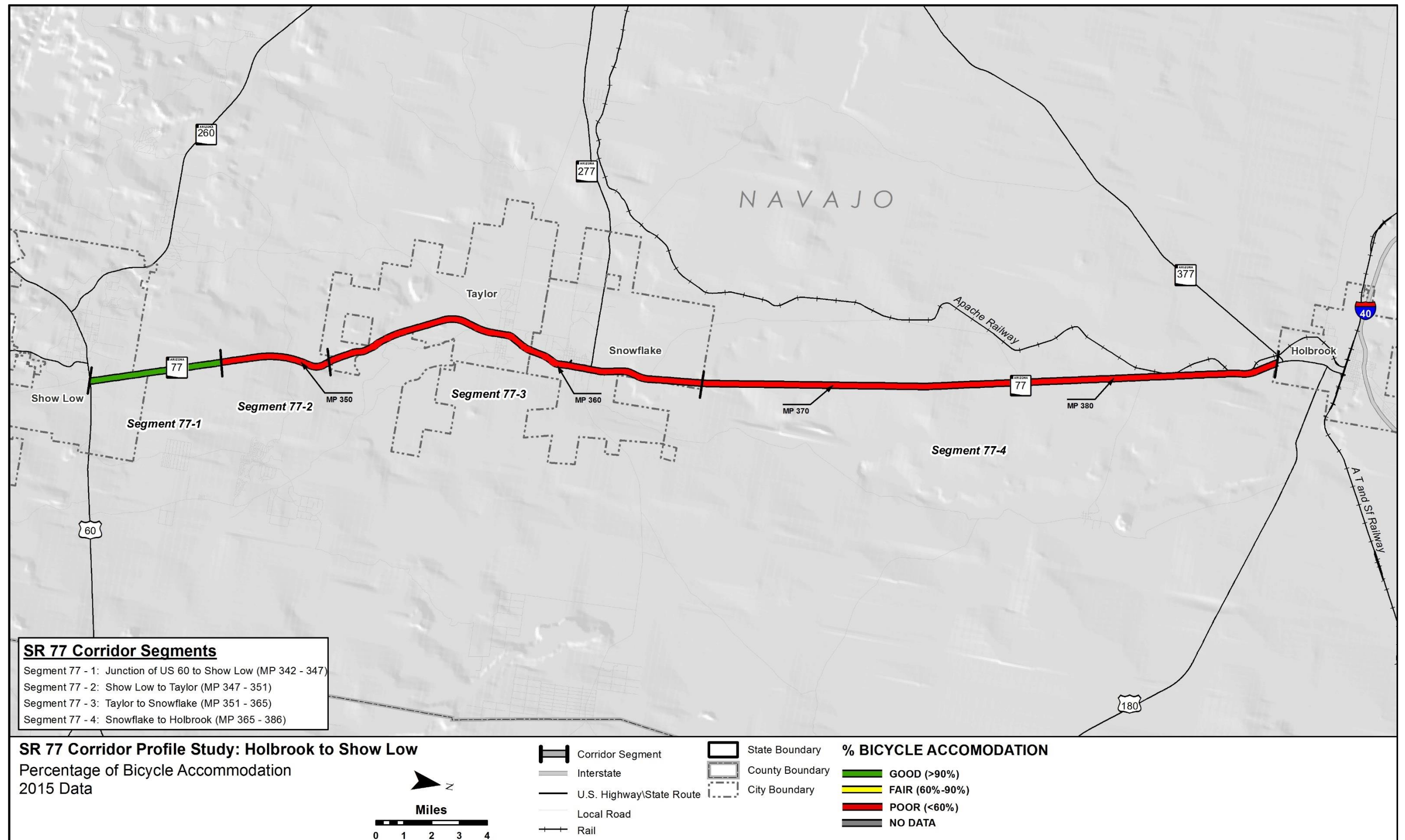


**ALL VEHICLES PLANNING TIME INDEX**

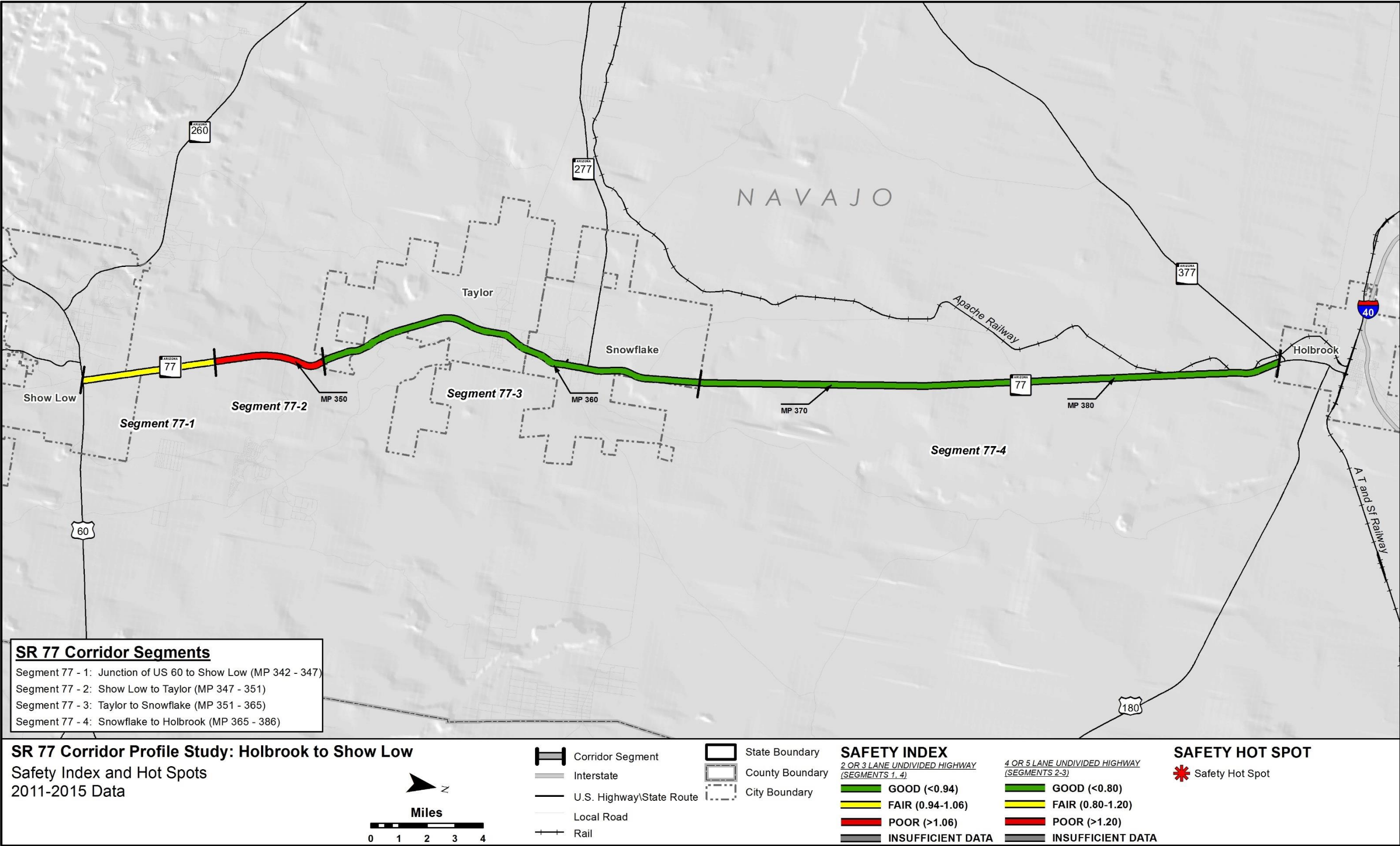




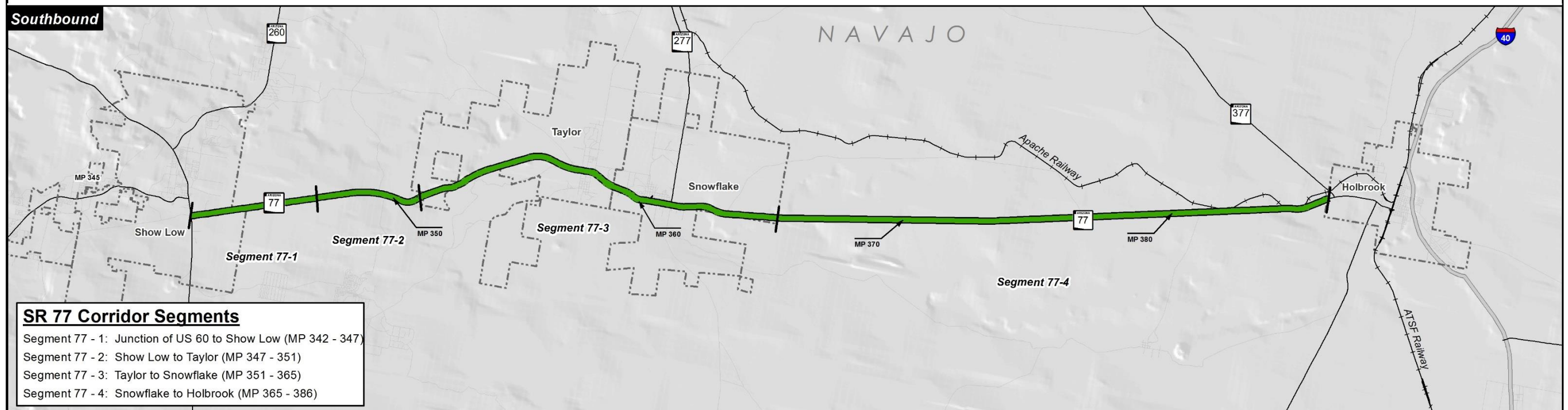
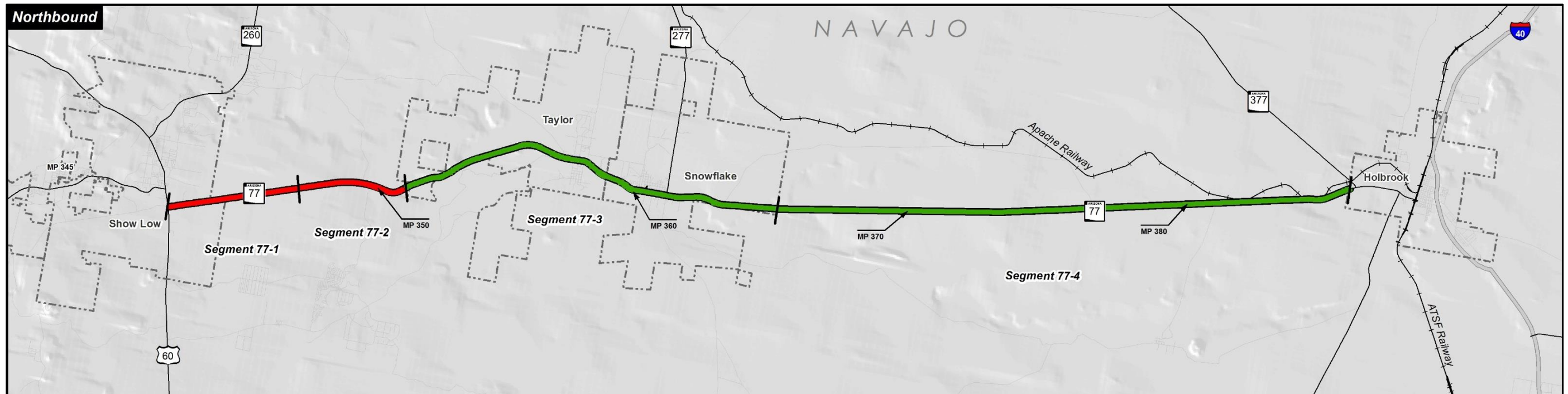








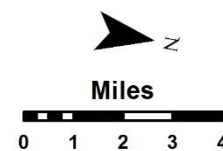




**SR 77 Corridor Segments**

Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
 Segment 77 - 2: Show Low to Taylor (MP 347 - 351)  
 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

**SR 77 Corridor Profile Study: Holbrook to Show Low**  
 Directional Safety Index and Hot Spots  
 2011-2015 Data



**SAFETY INDEX**

*2 OR 3 LANE UNDIVIDED HIGHWAY  
(SEGMENTS 1, 4)*



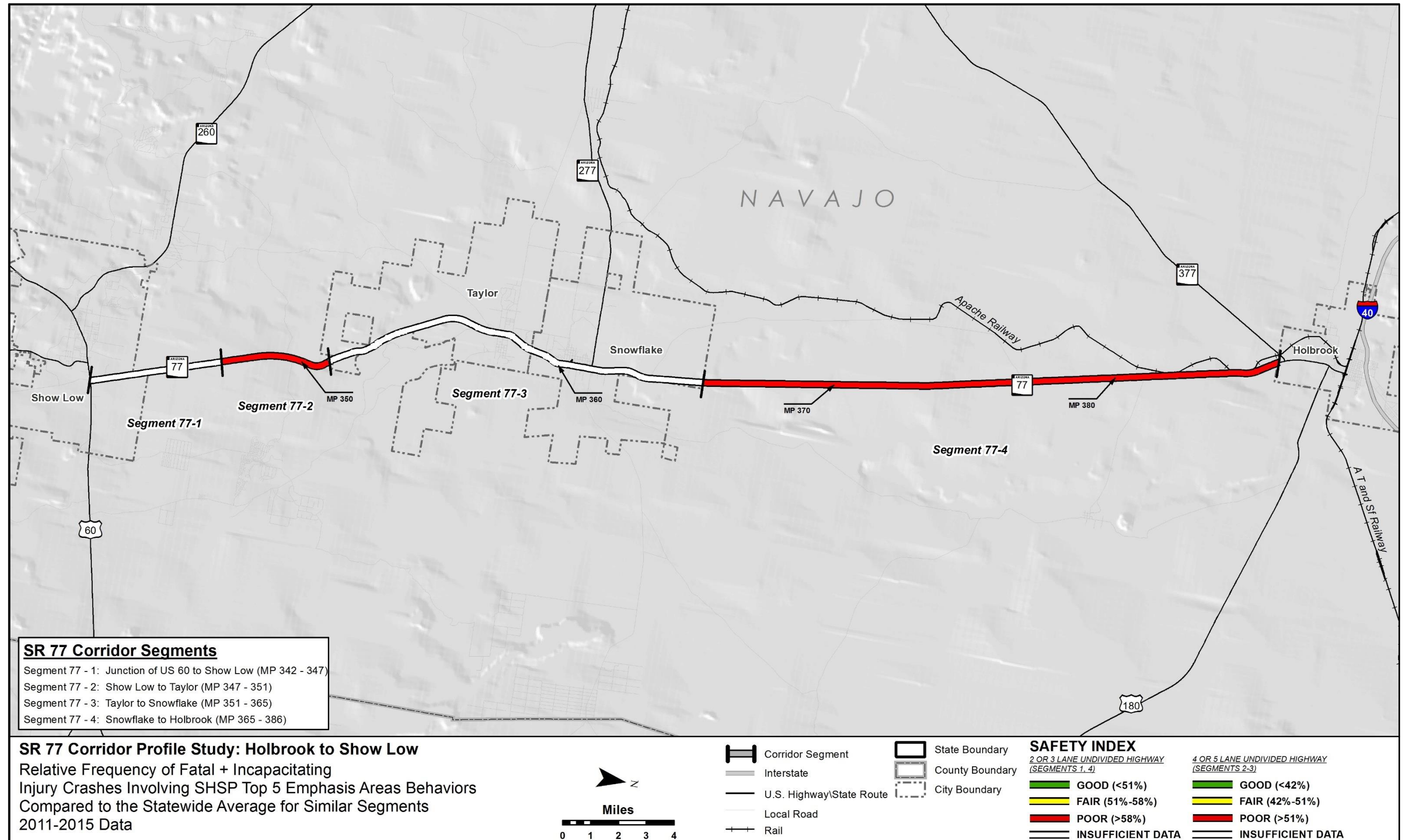
*4 OR 5 LANE UNDIVIDED HIGHWAY  
(SEGMENTS 2-3)*

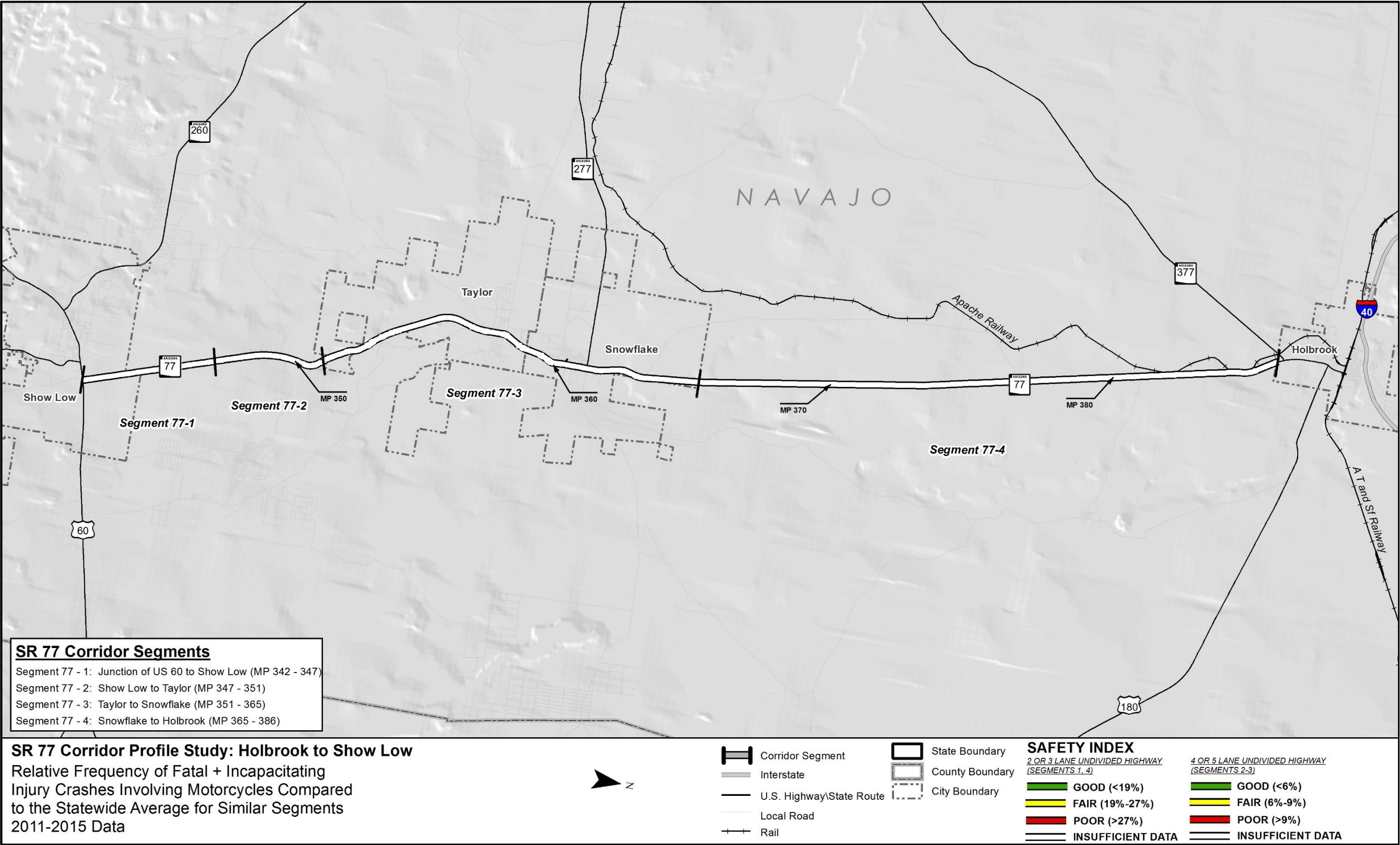


**SAFETY HOT SPOT**

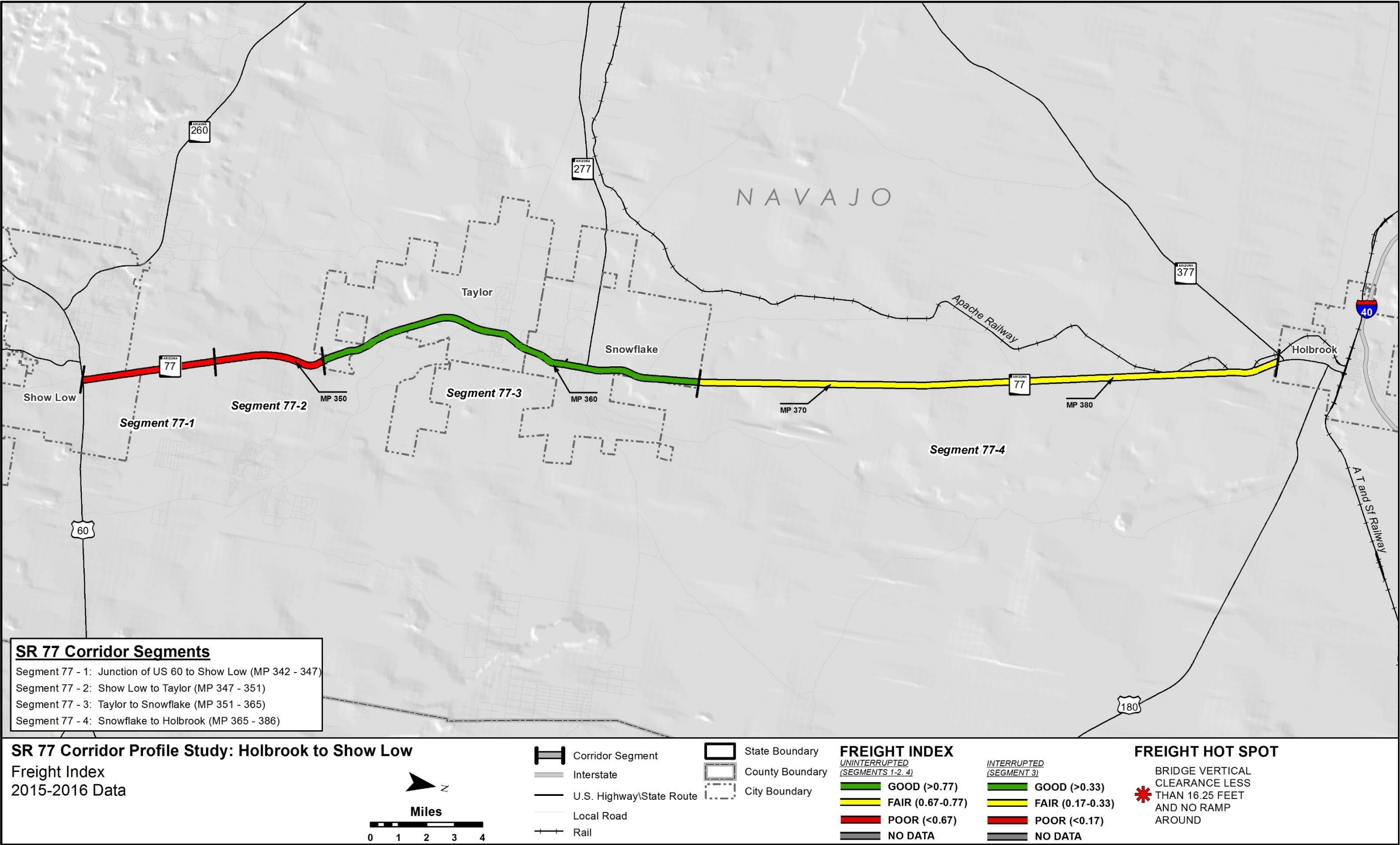
Safety Hot Spot



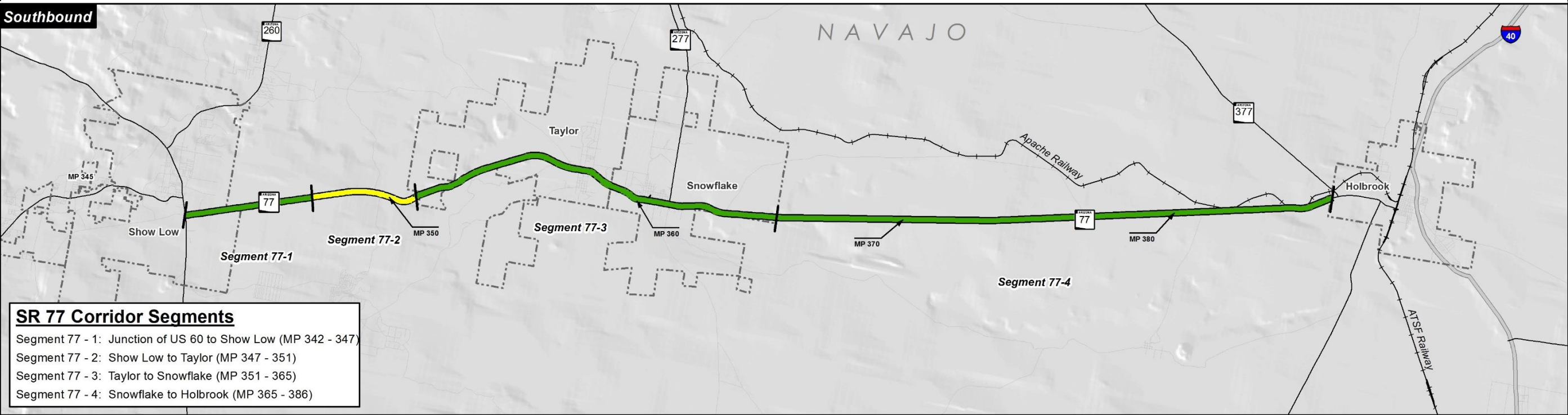
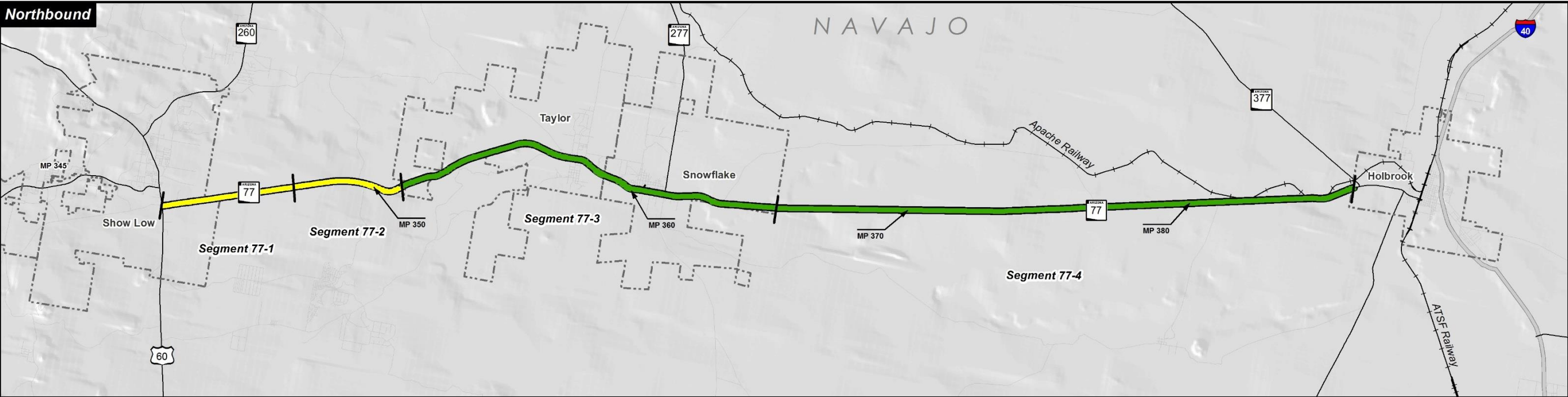








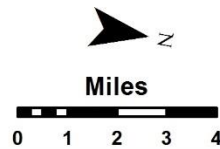




**SR 77 Corridor Segments**

Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
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Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

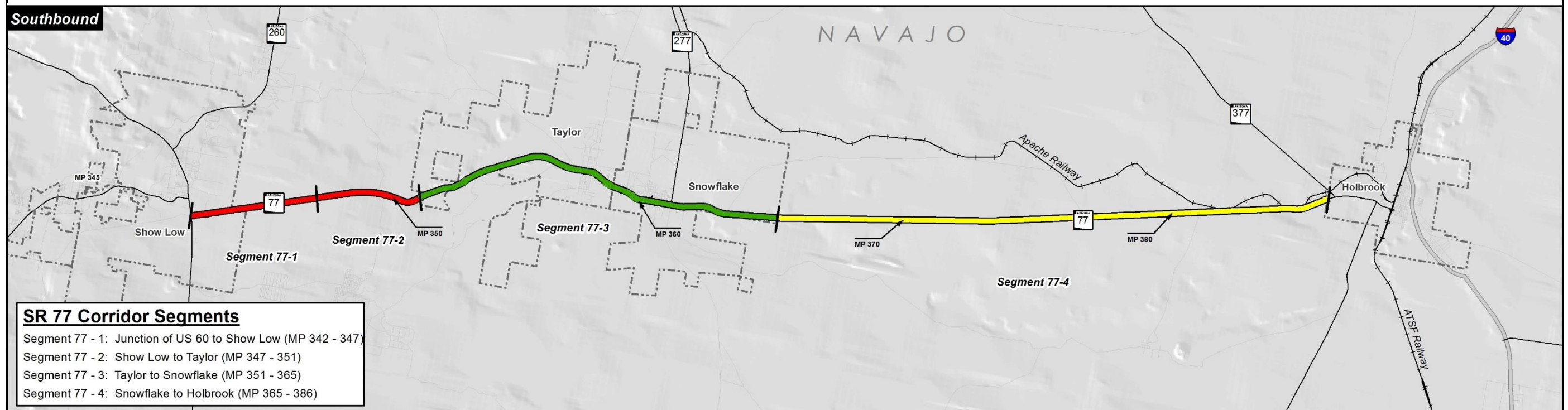
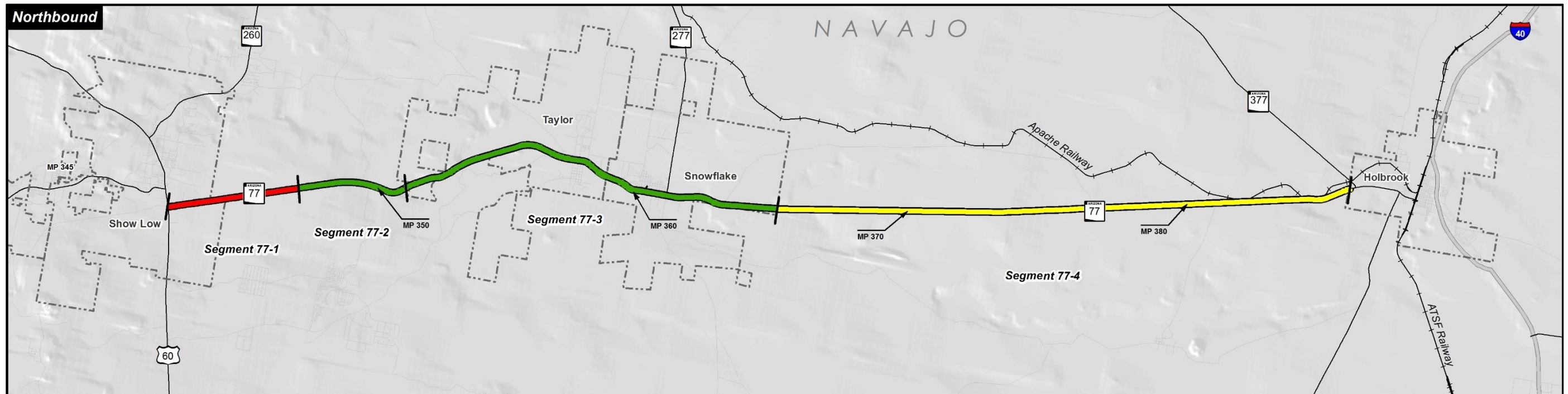
**SR 77 Corridor Profile Study: Holbrook to Show Low**  
Truck Travel Time Index  
2015-2016 Data



- Corridor Segment
- Interstate
- U.S. Highway/State Route
- Local Road
- Rail
- State Boundary
- County Boundary
- City Boundary

TRUCK TRAVEL TIME INDEX	
UNINTERRUPTED (SEGMENTS 1-2, 4)	INTERRUPTED (SEGMENT 3)
GOOD (<1.15)	GOOD (<1.3)
FAIR (1.15-1.33)	FAIR (1.3-2.0)
POOR (>1.33)	POOR (>2.0)
NO DATA	NO DATA



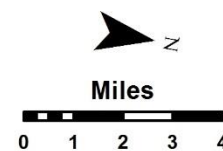


**SR 77 Corridor Segments**

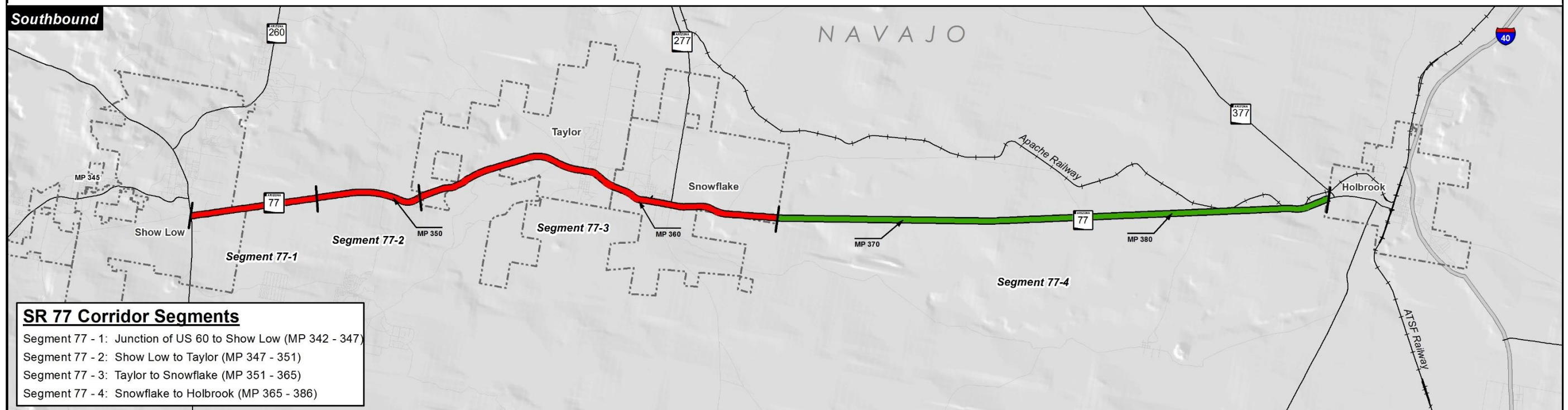
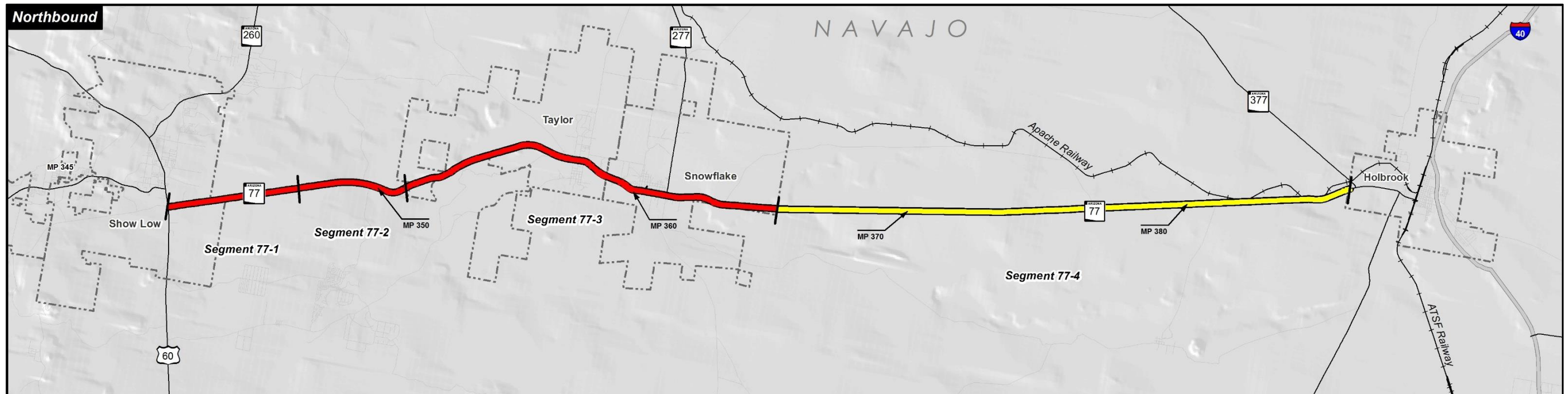
Segment 77 - 1: Junction of US 60 to Show Low (MP 342 - 347)  
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 Segment 77 - 3: Taylor to Snowflake (MP 351 - 365)  
 Segment 77 - 4: Snowflake to Holbrook (MP 365 - 386)

**SR 77 Corridor Profile Study: Holbrook to Show Low**

Truck Planning Time Index  
 2015-2016 Data





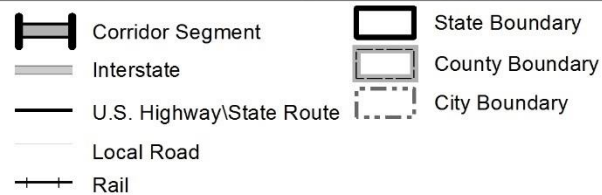
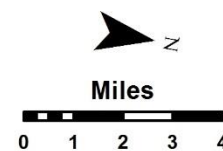


#### SR 77 Corridor Segments

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#### SR 77 Corridor Profile Study: Holbrook to Show Low

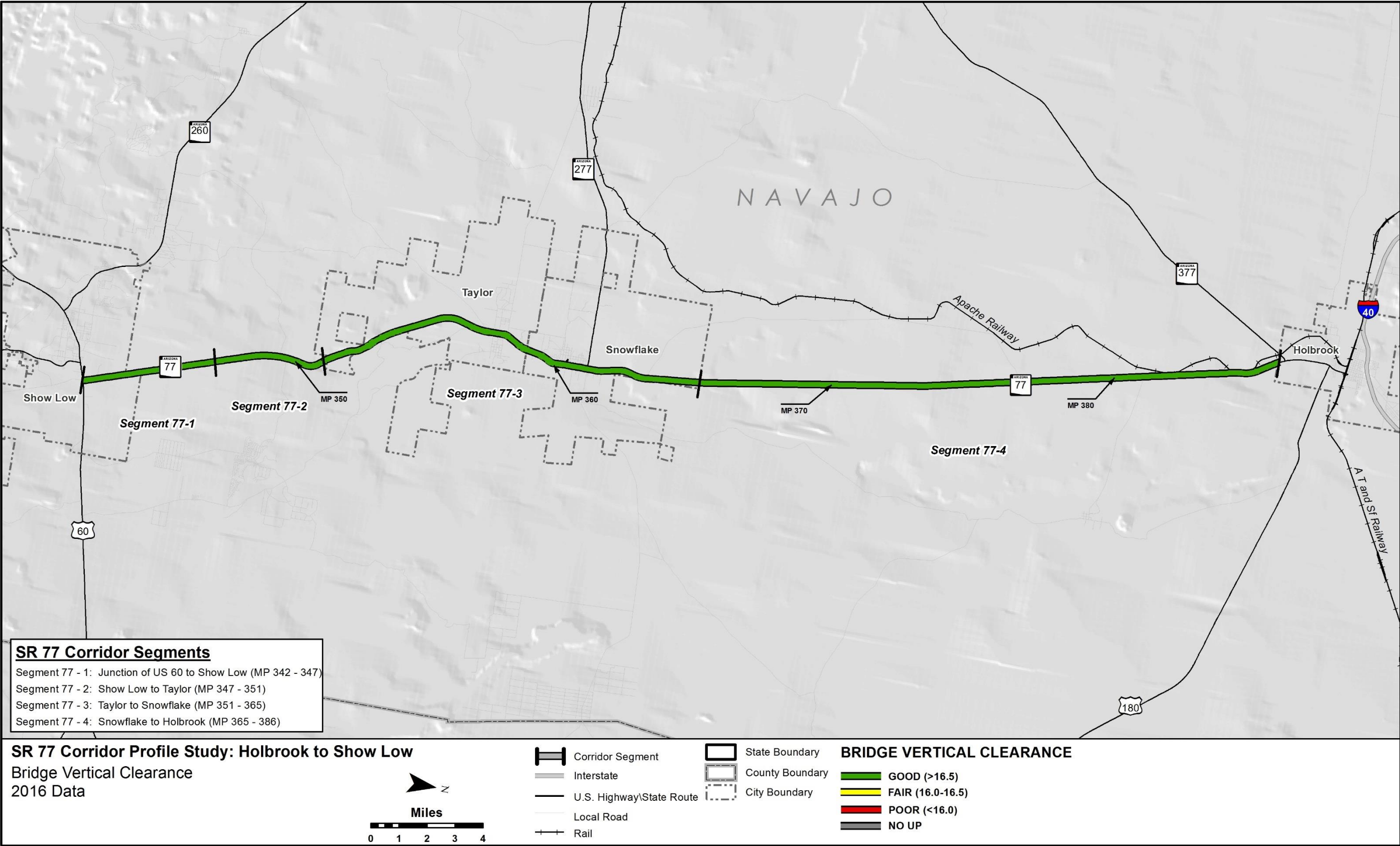
Average Minutes Per Year Given  
 Milepost is Closed Per Segment Mile  
 2015-2016 Data



#### MINUTES OF CLOSURE DURATION



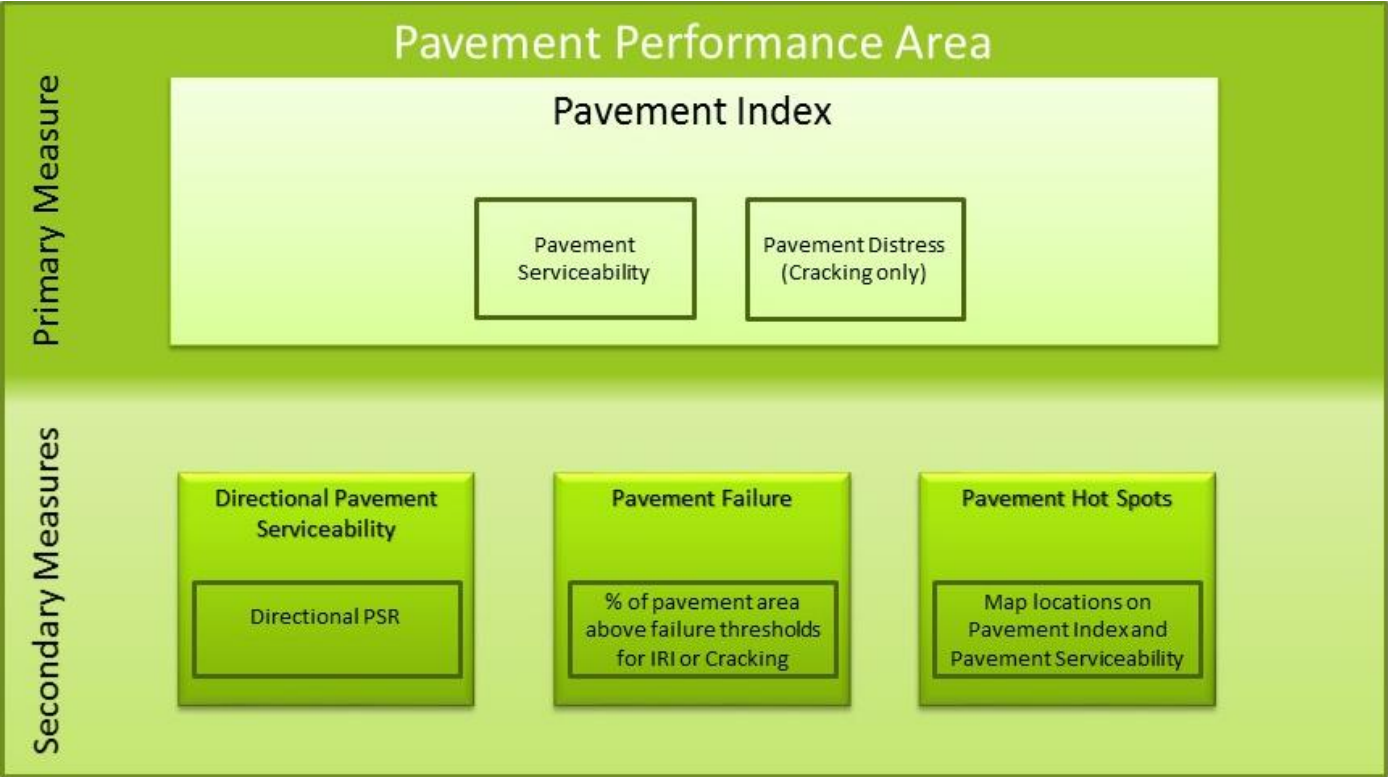




## **Appendix B: Performance Area Detailed Calculation Methodologies**

### Pavement Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Pavement performance area as shown in the following graphic:



This performance area is used to evaluate mainline pavement condition. Pavement condition data for ramps, frontage roads, crossroads, etc. was not included in the evaluation.

#### Primary Pavement Index

The Pavement Index is calculated based on the use of two pavement condition ratings from the ADOT Pavement Database. The two ratings are the International Roughness Index (IRI) and the Cracking rating. The calculation of the Pavement Index uses a combination of these two ratings.

The IRI is a measurement of the pavement roughness based on field-measured longitudinal roadway profiles. To facilitate the calculation of the index, the IRI rating was converted to a Pavement Serviceability Rating (PSR) using the following equation:

$$PSR = 5 * e^{-0.0038 * IRI}$$

The Cracking Rating is a measurement of the amount of surface cracking based on a field-measured area of 1,000 square feet that serves as a sample for each mile. To facilitate the calculation of the

index, the Cracking Rating was converted to a Pavement Distress Index (PDI) using the following equation:

$$PDI = 5 - (0.345 * C^{0.66})$$

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest performance. The performance thresholds for interstates and non-interstates shown in the tables below were used for the PSR and PDI.

Performance Level for Interstates	IRI (PSR)	Cracking (PDI)
Good	<75 (>3.75)	<7 (>3.75)
Fair	75 - 117 (3.20 - 3.75)	7 - 12 (3.22 - 3.75)
Poor	>117 (<3.20)	>12 (<3.22)

Performance Level for Non-Interstates	IRI (PSR)	Cracking (PDI)
Good	<94 (>3.5)	<9 (>3.5)
Fair	94 - 142 (2.9 - 3.5)	9 - 15 (2.9 - 3.5)
Poor	>142 (<2.9)	>15 (<2.9)

The PSR and PDI are calculated for each 1-mile section of roadway. If PSR or PDI falls into a poor rating (<3.2 for interstates, for example) for a 1-mile section, then the score for that 1-mile section is entirely (100%) based on the lower score (either PSR or PDI). If neither PSR or PDI fall into a poor rating for a 1-mile section, then the score for that 1-mile section is based on a combination of the lower rating (70% weight) and the higher rating (30% weight). The result is a score between 0 and 5 for each direction of travel of each mile of roadway based on a combination of both the PSR and the PDI.

The project corridor has been divided into segments. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than a section with fewer travel lanes.

#### Secondary Pavement Measures

Three secondary measures are evaluated:

- Directional Pavement Serviceability
- Pavement Failure
- Pavement Hot Spots



*Directional Pavement Serviceability:* Similar to the Pavement Index, the Directional Pavement Serviceability is calculated as a weighted average (based on number of lanes) for each segment. However, this rating only utilizes the PSR and is calculated separately for each direction of travel. The PSR uses a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest performance.

*Pavement Failure:* The percentage of pavement area rated above the failure thresholds for IRI or Cracking is calculated for each segment. In addition, the Standard score (z-score) is calculated for each segment.

The Standard score (z-score) is the number of standard deviations above or below the mean. Therefore, a Standard score between -0.5 and +0.5 is “average”, less than -0.5 is lower (better) than average, and higher than +0.5 is above (worse) than average.

*Pavement Hot Spots:* The Pavement Index map identifies locations that have an IRI rating or Cracking rating that fall above the failure threshold as identified by ADOT Pavement Group. For interstates, an IRI rating above 105 or a Cracking rating above 15 will be used as the thresholds which are slightly different than the ratings shown previously. For non-interstates, an IRI rating above 142 or a Cracking rating above 15 will be used as the thresholds.

Scoring

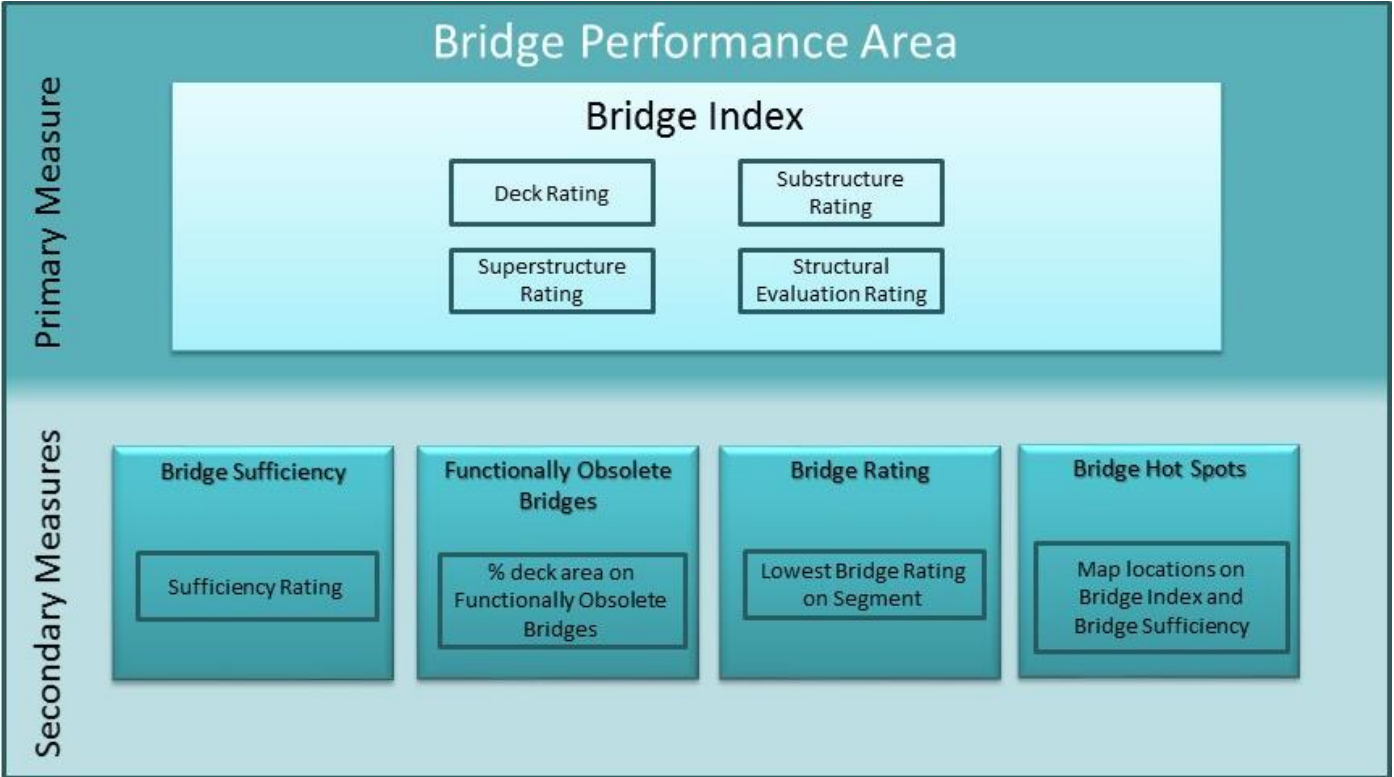
Performance Level	Pavement Index	
	Interstates	Non-Interstates
Good	>3.75	>3.5
Fair	3.2 - 3.75	2.9 - 3.5
Poor	<3.2	<2.9

Performance Level	Directional Pavement Serviceability	
	Interstates	Non-Interstates
Good	>3.75	>3.5
Fair	3.2 - 3.75	2.9 - 3.5
Poor	<3.2	<2.9

Performance Level	% Pavement Failure
Good	< 5%
Fair	5% – 20%
Poor	>20%

### Bridge Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Bridge performance area as shown in the following graphic:



This performance area is used to evaluate mainline bridges. Bridges on ramps (that do not cross the mainline), frontage roads, etc. should not be included in the evaluation. Basically, any bridge that carries mainline traffic or carries traffic over the mainline should be included and bridges that do not carry mainline traffic, run parallel to the mainline (frontage roads), or do not cross the mainline should not be included.

#### Primary Bridge Index

The Bridge Index is calculated based on the use of four bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. The calculation of the Bridge Index uses the lowest of these four ratings.

Each of the four condition ratings use a 0 to 9 scale with 0 representing the lowest performance and 9 representing the highest performance.

The project corridor has been divided into segments and the bridges are grouped together according to the segment definitions. In order to report the Bridge Index for each corridor segment, the Bridge Index for each segment is a weighted average based on the deck area for each bridge. Therefore,

the condition of a larger bridge will have a greater influence on the resulting segment Bridge Index than a smaller bridge.

#### Secondary Bridge Measures

Four secondary measures will be evaluated:

- Bridge Sufficiency
- Functionally Obsolete Bridges
- Bridge Rating
- Bridge Hot Spots

*Bridge Sufficiency:* Similar to the Bridge Index, the Bridge Sufficiency rating is calculated as a weighted average (based on deck area) for each segment. The Bridge Sufficiency rating is a scale of 0 to 100 with 0 representing the lowest performance and 100 representing the highest performance. A rating of 80 or above represents “good” performance, a rating between 50 and 80 represents “fair” performance, and a rating below 50 represents “poor” performance.

*Functionally Obsolete Bridges:* The percentage of total deck area in a segment that is on functionally obsolete bridges is calculated for each segment. The deck area for each bridge within each segment that has been identified as functionally obsolete is totaled and divided by the total deck area for the segment to calculate the percentage of deck area on functionally obsolete bridges for each segment.

The thresholds for this performance measure are determined based on the Standard score (z-score). The Standard score (z-score) is the number of standard deviations above or below the mean. Therefore, a Standard score between -0.5 and +0.5 is “average”, less than -0.5 is lower (better) than average, and higher than +0.5 is above (worse) average.

*Bridge Rating:* The Bridge Rating simply identifies the lowest bridge rating on each segment. This performance measure is not an average and therefore is not weighted based on the deck area. The Bridge Index identifies the lowest rating for each bridge, as described above. Each of the four condition ratings use a 0 to 9 scale with 0 representing the lowest performance and 9 representing the highest performance.

*Bridge Hot Spots:* The Bridge Index map identifies individual bridge locations that are identified as hot spots. Hot spots are bridges that have a single rating of 4 in any of the four ratings, or multiple ratings of 5 in the deck, substructure or superstructure ratings.

Scoring:

Performance Level	Bridge Index
Good	>6.5
Fair	5.0-6.5
Poor	<5.0

Performance Level	Sufficiency Rating
Good	>80
Fair	50-80
Poor	<50

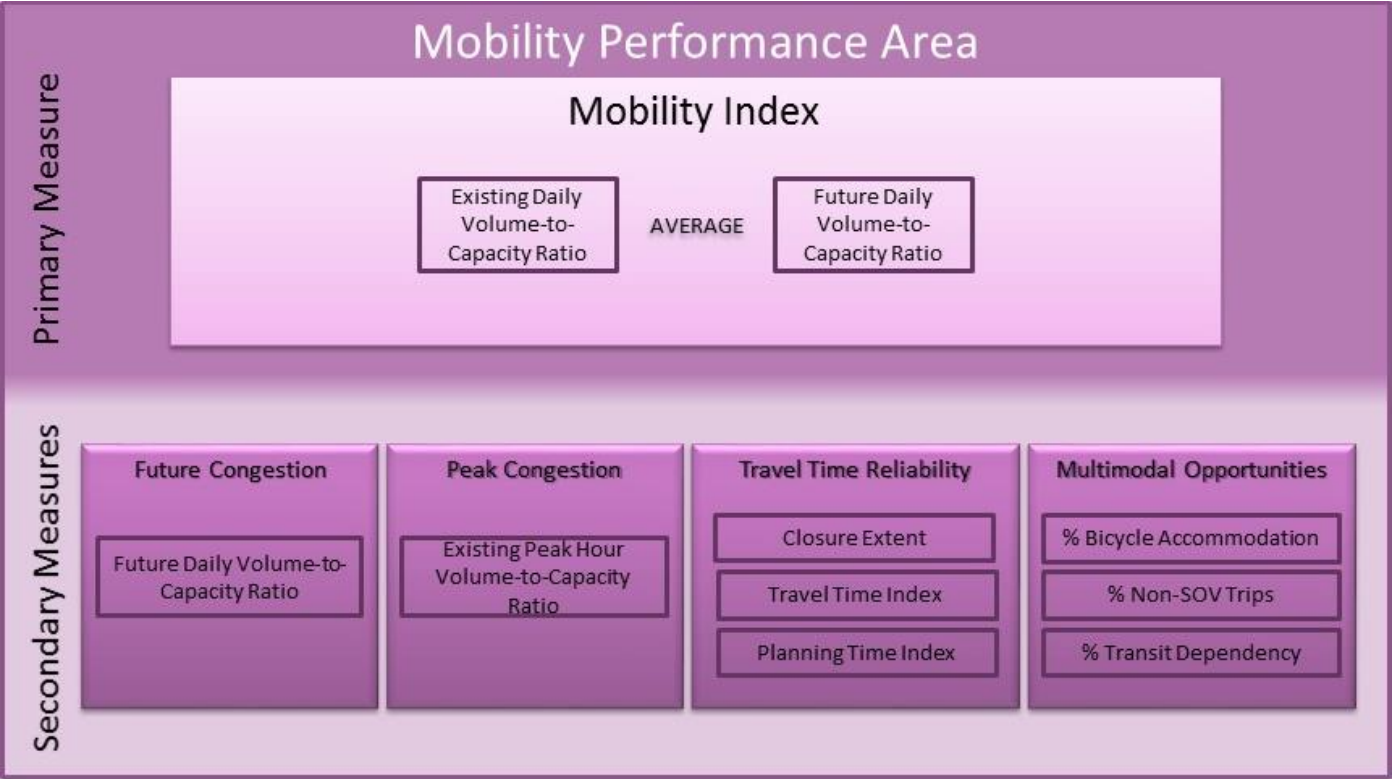
Performance Level	Bridge Rating
Good	>6
Fair	5-6
Poor	<5

Performance Level	% Functionally Obsolete
Good	< 12%
Fair	12%-40%
Poor	>40%



## Mobility Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Mobility performance area as shown in the following graphic:



### Primary Mobility Index

The primary Mobility Index is an average of the existing daily volume-to-capacity (V/C) ratio and the future daily V/C ratio for each segment of the corridor.

*Existing Daily V/C:* The existing daily V/C ratio for each segment is calculated by dividing the 2014 Annual Average Daily Traffic (AADT) volume for each segment by the total Level of Service (LOS) E capacity volume for that segment

The capacity is calculated using the HERS Procedures for Estimating Highway Capacity<sup>2</sup>. The HERS procedure incorporates HCM 2010 methodologies. The methodology includes capacity estimation procedures for multiple facility types including freeways, rural two-lane highways, multilane highways, and signalized and non-signalized urban sections.

The segment capacity is defined as a function of the number of mainline lanes, shoulder width, interrupted or uninterrupted flow facilities, terrain type, percent of truck traffic, and the designated urban or rural environment.

The AADT for each segment is calculated by applying a weighted average across the length of the segment based on the individual 24-hour volumes and distances associated with each HPMS count station within each segment.

The following example equation is used to determine the weighted average of a segment with two HPMS count locations within the corridor

$$\frac{((HPMS\ 1\ Distance \times HPMS\ 1\ Volume) + (HPMS\ 2\ Distance \times HPMS\ 2\ Volume))}{Total\ Segment\ Length}$$

For specific details regarding the HERS methodology used, refer to the *Procedures for Estimating Highway Capacity, draft Technical Memorandum*.

*Future Daily V/C:* The future daily V/C ratio for each segment is calculated by dividing the 2035 AADT volume for each segment by the 2014 LOS E capacity. The capacity volume used in this calculation is the same as is utilized in the existing daily V/C equation.

The future AADT daily volumes are generated by applying an average annual compound growth rate (ACGR) to each 2014 AADT segment volume. The following equation is used to apply the average annual compound growth rate:

$$2035\ AADT = 2014\ AADT \times ((1+ACGR)^{(2035-2014)})$$

The ACGR for each segment is defined by comparing the total volumes in the 2010 Arizona Travel Demand Model (AZTDM2) to the 2035 AZTDM2 traffic volumes at each existing HPMS count station location throughout the corridor. Each 2010 and 2035 segment volume is defined using the same weighted average equation described in the *Existing Daily V/C* section above and then summing the directional volumes for each location. The following equation is used to determine the ACGR for each segment:

$$ACGR = ((2035\ Volume/2010\ Volume)^{(1/(2035-2010))})-1$$

### Secondary Mobility Measures

Four secondary measures are evaluated:

- Future Congestion
- Peak Congestion
- Travel Time Reliability

<sup>2</sup> HERS Support – 2011, Task 6: Procedures for Estimating Highway Capacity, draft Technical Memorandum. Cambridge Systematics. Prepared for the Federal Highway Administration. March 2013.

- Closure Extent
- Directional Travel Time Index
- Directional Planning Time Index
- Multimodal Opportunities
  - % Bicycle Accommodation
  - % Non-Single Occupancy Vehicle (SOV) Trips
  - % Transit Dependency

**Future Congestion:** The future daily V/C ratios for each segment in the corridor that are calculated and used in the Mobility Index as part of the overall average between Existing Daily V/C and Future Daily V/C are applied independently as a secondary measure. The methods to calculate the Future Daily V/C can be referenced in the Mobility Index section.

**Peak Congestion:** Peak Congestion has been defined as the peak hour V/C ratio in both directions of the corridor. The peak hour V/C ratio is calculated using the HERS method as described previously. The peak hour volume utilizes the directional AADT for each segment, which is calculated by applying a weighted average across the length of the segment based on the individual directional 24-hour volumes and distances associated with each HPMS count station within each segment. The segment capacity is defined based on the characteristics of each segment including number of lanes, terrain type, and environment, similar to the 24-hour volumes using the HERS method.

**Travel Time Reliability:** Travel time reliability is a secondary measure that includes three indicators. The three indicators are the number of times a piece of a corridor is closed for any specific reason, the directional Travel Time Index (TTI), and the directional Planning Time Index (PTI).

**Closure Extent:** The number of times a roadway is closed is documented through the HCRS dataset. Closure Extent is defined as the average number of times a particular milepost of the corridor is closed per year per mile in a specific direction of travel. The weighted average of each occurrence takes into account the distance over which a specific occurrence spans.

Thresholds that determine levels of good, fair, and poor are based on the average number of closures per mile per year within each of the identified statewide significant corridors by ADOT. The thresholds shown at the end of this section represent statewide averages across those corridors.

**Directional Travel Time and Planning Time Index:** In terms of overall mobility, the TTI is the relationship of the mean peak period travel time in a specific section of the corridor to the free-flow travel time in the same location. The PTI is the relationship of the 95<sup>th</sup> percentile highest travel time to the free-flow travel time (based on the posted speed limit) in a specific section of the corridor. The TTI and PTI can be converted into speed-based indices by recognizing that speed is equal to distance traveled divided by travel time. The inverse relationship between travel time and speed means that the 95<sup>th</sup> percentile highest travel time corresponds to the 5<sup>th</sup> percentile lowest speed.

Using HERE data provided by ADOT, four time periods for each data point were collected throughout the day (AM peak, mid-day, PM peak, and off-peak). Using the mean speeds and 5<sup>th</sup> percentile lowest mean speeds collected over 2014 for these time periods for each data location, four TTI and PTI calculations were made using the following formulas:

$$TTI = \text{Posted Speed Limit} / \text{Mean Peak Hour Speed}$$

$$PTI = \text{Posted Speed Limit} / 5^{\text{th}} \text{ Percentile Lowest Speed}$$

The highest value of the four time periods calculation is defined as the TTI for that data point. The average TTI is calculated within each segment based on the number of data points collected. The value of the average TTI across each entry is used as the TTI for each respective segment within the corridor.

**Multimodal Opportunities:** Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to a single occupancy vehicle (SOV) for trips along the corridor. The three indicators include the percent bicycle accommodation, non-SOV trips, and transit dependency along the corridor.

**Percent Bicycle Accommodation:** For this secondary performance evaluation, outside shoulder widths are evaluated considering the roadway's context and conditions. This requires use of the roadway data that includes right shoulder widths, shoulder surface types, and speed limits, all of which are available in the following ADOT geographic information system (GIS) data sets:

- Right Shoulder Widths
- Left Shoulder Widths (for undivided roadways)
- Shoulder Surface Type (Both Left/Right)
- Speed Limit

Additionally, each segment's average AADT, estimated earlier in the Mobility performance area methodology, is used for the criteria to determine if the existing shoulder width meets the effective width.

The criteria for screening if a shoulder segment meets the recommended width criteria are as followed:

- (1) If AADT <= 1500 OR Speed Limit <= 25 miles per hour (mph):  
The segment's general purpose lane can be shared with bicyclists (no effective shoulder width required)
- (2) If AADT > 1500 AND Speed Limit between (25 - 50 mph) AND Pavement Surface is Paved:  
Effective shoulder width required is 4 feet or greater
- (3) If AADT > 1500 AND Speed Limit >= 50 mph and Pavement Surface is Paved:  
Effective shoulder width required is 6 feet or greater

The summation of the length of the shoulder sections that meet the defined effective width criteria, based on criteria above, is divided by the segment's total length to estimate the percent of the segment that accommodates bicycles as illustrated at the end of this section. If shoulder data is not available or appears erroneous, field measurements can substitute for the shoulder data.

**Percent Non-SOV Trips:** The percentage of non-SOV trips over distances less than 50 miles gives an indication of travel patterns along a section of the corridor that could benefit from additional multimodal options in the future.

Thresholds that determine levels of good, fair, and poor are based on the percent non-SOV trips within each of the identified statewide significant corridors by ADOT. The thresholds shown at the end of this section represent statewide averages across those corridors.

**Percent Transit Dependency:** 2008-2012 U.S. Census American Community Survey tract and state level geographic data and attributes from the tables B08201 (Number of Vehicles Available by Household Size) and B17001 (Population in Poverty within the Last 12 Months) were downloaded with margins of error included from the Census data retrieval application Data Ferret. Population ranges for each tract were determined by adding and subtracting the margin of error to each estimate in excel. The tract level attribute data was then joined to geographic tract data in GIS. Only tracts within a one mile buffer of each corridor are considered for this evaluation.

Tracts that have a statistically significantly larger number of either people in poverty or households with only one or no vehicles available than the state average are considered potentially transit dependent.

**Example:** The state average for zero or one vehicles households (HHs) is between 44.1% and 45.0%. Tracts which have the lower bound of their range above the upper bound of the state range have a greater percentage of zero/one vehicle HHs than the state average. Tracts that have their upper bound beneath the lower bound of the state range have a lesser percentage of zero/one vehicles HHs than the state average. All other tracts that have one of their bounds overlapping with the state average cannot be considered statistically significantly different because there is a chance the value is actually the same.

In addition to transit dependency, the following attributes are added to the Multimodal Opportunities map based on available data.

- Shoulder width throughout the corridor based on 'Shoulder Width' GIS dataset provided by ADOT
- Intercity bus routes
- Multiuse paths within the corridor right-of-way, if applicable

**Scoring:**

Volume-to-Capacity Ratios		
Urban and Fringe Urban		
Good - LOS A-C	$V/C \leq 0.71$	*Note - ADOT Roadway Design Standards indicate Urban and Fringe Urban roadways should be designed to level of service C or better
Fair - LOS D	$V/C > 0.71 \text{ \& } \leq 0.89$	
Poor - LOS E or less	$V/C > 0.89$	
Rural		
Good - LOS A-B	$V/C \leq 0.56$	*Note - ADOT Roadway Design Standards indicate Rural roadways should be designed to level of service B or better
Fair - LOS C	$V/C > 0.56 \text{ \& } \leq 0.76$	
Poor - LOS D or less	$V/C > 0.76$	

Performance Level	Closure Extent
Good	$\leq 0.22$
Fair	$> 0.22 \text{ \& } \leq 0.62$
Poor	$V/C > 0.62$

Performance Level	TTI on Uninterrupted Flow Facilities
Good	$< 1.15$
Fair	$\geq 1.15 \text{ \& } < 1.33$
Poor	$\geq 1.33$

Performance Level	TTI on Interrupted Flow Facilities
Good	$< 1.30$
Fair	$\geq 1.30 \text{ \& } < 1.2.00$
Poor	$\geq 2.00$

Performance Level	PTI on Uninterrupted Flow Facilities
Good	$< 1.30$
Fair	$\geq 1.30 \text{ \& } < 1.50$
Poor	$\geq 1.50$

Performance Level	PTI Interrupted Flow Facilities
Good	$< 3.00$
Fair	$\geq 3.00 \text{ \& } < 6.00$
Poor	$\geq 6.00$



Performance Level	Percent Bicycle Accommodation
Good	$\geq 90\%$
Fair	$> 60\% \ \& \ \leq 90\%$
Poor	$< 60\%$

Performance Level	Percent Non-SOV Trips
Good	$\geq 17\%$
Fair	$> 11\% \ \& \ \leq 17\%$
Poor	$< 11\%$

Performance Level	Percent Transit Dependency
Good	Tracts with both zero and one vehicle household population in poverty percentages below the statewide average
Fair	Tracts with either zero and one vehicle household or population in poverty percentages below the statewide average
Poor	Tracts with both zero and one vehicle household and population in poverty percentages above the statewide average

Safety Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Safety performance area as shown in the following graphic:



Primary Safety Index

The Safety Index is a safety performance measure based on the bi-directional (i.e., both directions combined) frequency and rate of fatal and incapacitating injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT’s 2010 Highway Safety Improvement Program Manual, fatal crashes have an estimated cost that is 14.5 times the estimated cost of incapacitating injury crashes (\$5.8 million compared to \$400,000).

The Combined Safety Score (CSS) is an interim measure that combines fatal and incapacitating injury crashes into a single value. The CSS is calculated using the following generalized formula:

CSS = 14.5 \* (Normalized Fatal Crash Rate + Frequency) + (Normalized Incapacitating Injury Crash Rate + Frequency)

Because crashes vary depending on the operating environment of a particular roadway, statewide CSS values were developed for similar operating environments defined by functional classification, urban vs. rural setting, number of travel lanes, and traffic volumes. To determine the Safety Index of a particular segment, the segment CSS is compared to the average statewide CSS for the similar statewide operating environment.

The Safety Index is calculated using the following formula:

Safety Index = Segment CSS / Statewide Similar Operating Environment CSS

The average annual Safety Index for a segment is compared to the statewide similar operating environment annual average, with one standard deviation from the statewide average forming the scale break points.

The more a particular segment’s Safety Index value is below the statewide similar operating environment average, the better the safety performance is for that particular segment as a lower value represents fewer crashes.

Scoring:

The scale for rating the Safety Index depends on the operating environments selected, as shown in the table below.

Similar Operating Environment	Safety Index (Overall & Directional)	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	0.94	1.06
2 or 3 or 4 Lane Divided Highway	0.77	1.23
4 or 5 Lane Undivided Highway	0.80	1.20
6 Lane Highway	0.56	1.44
Rural 4 Lane Freeway with Daily Volume < 25,000	0.73	1.27
Rural 4 Lane Freeway with Daily Volume > 25,000	0.68	1.32
Urban 4 Lane Freeway	0.79	1.21
Urban or Rural 6 Lane Freeway	0.82	1.18
Urban > 6 Lane Freeway	0.80	1.20

\* Lower/upper limit of Average calculated as one standard deviation below/above the Mean

Some corridor segments may have a very low number of total fatal and incapacitating injury crashes. Low crash frequencies (i.e., a small sample size) can translate into performance ratings that can be unstable. In some cases, a change in crash frequency of one crash (one additional crash or one less crash) could result in a change in segment performance of two levels. To avoid reliance on performance ratings where small changes in crash frequency result in large changes in performance, the following two criteria were developed to identify segments with “insufficient data” for assessing performance for the Safety Index. Both of these criteria must be met for a segment to have “insufficient data” to reliably rate the Safety Index performance:

- If the crash sample size (total fatal plus incapacitating injury crashes) for a given segment is less than five crashes over the five-year analysis period; AND

- If a change in one crash results in a change in segment performance by two levels (i.e., a change from below average to above average performance or a change from above average to below average frequency), the segment has “insufficient data” and Safety Index performance ratings are unreliable.

### Secondary Safety Measures

The Safety performance area has four secondary measures related to fatal and incapacitating injury crashes:

- Directional Safety Index
- Strategic Highway Safety Plan (SHSP) Behavior Emphasis Areas
- Crash Unit Types
- Safety Hot Spots

**Directional Safety Index:** The Direction Safety Index shares the same calculation procedure and thresholds as the Safety Index. However, the measure is based on the directional frequency and rate of fatal and incapacitating injury crashes.

Similar to the Safety Index, the segment CSS is compared to the average statewide CSS for the similar statewide operating environment. The Directional Safety Index follows the lead of the Safety Index in terms of “insufficient data” status. If the Safety Index meets both criteria for “insufficient data”, the Directional Safety Index should also be changed to “insufficient data”. If the Safety Index does not meet both criteria for “insufficient data”, the Directional Safety Index would also not change to say “insufficient data”

**SHSP Behavior Emphasis Areas:** ADOT’s 2014 SHSP identifies several emphasis areas for reducing fatal and incapacitating injury crashes. The top five SHSP emphasis areas relate to the following driver behaviors:

- Speeding and aggressive driving
- Impaired driving
- Lack of restraint usage
- Lack of motorcycle helmet usage
- Distracted driving

To develop a performance measure that reflects these five emphasis areas, the percentage of total fatal and incapacitating injury crashes that involves at least one of the emphasis area driver behaviors on a particular segment is compared to the statewide average percentage of crashes involving at least one of the emphasis area driver behaviors on roads with similar operating environments in a process similar to how the Safety Index is developed.

To increase the crash sample size for this performance measure, the five behavior emphasis areas are combined to identify fatal and incapacitating injury crashes that exhibit one or more of the behavior emphasis areas.

The SHSP behavior emphasis areas performance is calculated using the following formula:

$$\% \text{ Crashes Involving SHSP Behavior Emphasis Areas} = \frac{\text{Segment Crashes Involving SHSP Behavior Emphasis Areas}}{\text{Total Segment Crashes}}$$

The percentage of total crashes involving SHSP behavior emphasis areas for a segment is compared to the statewide percentages on roads with similar operating environments. One standard deviation from the statewide average percentage forms the scale break points.

When assessing the performance of the SHSP behavior emphasis areas, the more the frequency of crashes involving SHSP behavior emphasis areas is below the statewide average implies better levels of segment performance. Thus, lower values are better, similar to the Safety Index.

### Scoring:

The scale for rating the SHSP behavior emphasis areas performance depends on the crash history on similar statewide operating environments, as shown in the table below:

Similar Operating Environment	Crashes in SHSP Top 5 Emphasis Areas	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	51.2%	57.5%
2 or 3 or 4 Lane Divided Highway	44.4%	54.4%
4 or 5 Lane Undivided Highway	42.4%	51.1%
6 Lane Highway	35.3%	46.5%
Rural 4 Lane Freeway with Daily Volume < 25,000	42.8%	52.9%
Rural 4 Lane Freeway with Daily Volume > 25,000	40.8%	57.1%
Urban 4 Lane Freeway	49.1%	59.4%
Urban or Rural 6 Lane Freeway	33.5%	57.2%
Urban > 6 Lane Freeway	42.6%	54.8%

\* Lower/upper limit of Average calculated as one standard deviation below/above the Mean

The SHSP behavior emphasis areas secondary safety performance measure for the Safety performance area includes proportions of specific types of crashes within the total fatal and incapacitating injury crash frequencies. This more detailed categorization of fatal and incapacitating injury crashes can result in low crash frequencies (i.e., a small sample size) that translate into performance ratings that can be unstable. In some cases, a change in crash frequency of one crash (one additional crash or one less crash) could result in a change in segment performance of two levels. To avoid reliance on performance ratings where small changes in crash frequency result in large changes in performance, the following criteria were developed to identify segments with “insufficient data” for assessing performance for the SHSP behavior emphasis areas secondary



safety performance measure. If any of these criteria are met for a segment, that segment has “insufficient data” to reliably rate the SHSP behavior emphasis areas performance:

- If the crash sample size (total fatal plus incapacitating injury crashes) for a given segment is less than five crashes over the five-year analysis period, the segment has “insufficient data” and performance ratings are unreliable. OR
- If a change in one crash results in a change in segment performance by two levels (i.e., a change from below average to above average performance or a change from above average to below average frequency), the segment has “insufficient data” and performance ratings are unreliable. OR
- If the corridor average segment crash frequency for the SHSP behavior emphasis areas performance measure is less than two crashes over the five-year analysis period, the entire SHSP behavior emphasis areas performance measure has “insufficient data” and performance ratings are unreliable.

*Crash Unit Type Emphasis Areas:* ADOT’s SHSP also identifies emphasis areas that relate to the following “unit-involved” crashes:

- Heavy vehicle (trucks)-involved crashes
- Motorcycle-involved crashes
- Non-motorized traveler (pedestrians and bicyclists)-involved crashes

To develop a performance measure that reflects the aforementioned crash unit type emphasis areas, the percentage of total fatal and incapacitating injury crashes that involves a given crash unit type emphasis area on a particular segment is compared to the statewide average percentage of crashes involving that same crash unit type emphasis area on roads with similar operating environments in a process similar to how the Safety Index is developed.

The SHSP crash unit type emphasis areas performance is calculated using the following formula:

$$\% \text{ Crashes Involving Crash Unit Type} = \frac{\text{Segment Crashes Involving Crash Unit Type}}{\text{Total Segment Crashes}}$$

The percentage of total crashes involving crash unit types for a segment is compared to the statewide percentages on roads with similar operating environments. One standard deviation from the statewide average percentage forms the scale break points.

When assessing the performance of the crash unit types, the more the frequency of crashes involving crash unit types is below the statewide average implies better levels of segment performance. Thus, lower values are better, similar to the Safety Index. The scale for rating the unit-involved crash performance depends on the crash history on similar statewide operating environments, as shown in the following tables.

Scoring:

Similar Operating Environment	Crashes Involving Trucks	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	5.2%	7.1%
2 or 3 or 4 Lane Divided Highway	3.5%	7.3%
4 or 5 Lane Undivided Highway	6.1%	9.6%
6 Lane Highway	0.3%	8.7%
Rural 4 Lane Freeway with Daily Volume < 25,000	13.2%	17.0%
Rural 4 Lane Freeway with Daily Volume > 25,000	7.2%	12.9%
Urban 4 Lane Freeway	6.8%	10.9%
Urban or Rural 6 Lane Freeway	6.2%	11.0%
Urban > 6 Lane Freeway	2.5%	6.0%

\* Lower/upper limit of Average calculated as one standard deviation below/above the Mean

Similar Operating Environment	Crashes Involving Motorcycles	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	18.5%	26.5%
2 or 3 or 4 Lane Divided Highway	16.3%	26.3%
4 or 5 Lane Undivided Highway	6.4%	9.4%
6 Lane Highway	0.0%	20.0%
Rural 4 Lane Freeway with Daily Volume < 25,000	5.0%	8.5%
Rural 4 Lane Freeway with Daily Volume > 25,000	7.7%	17.1%
Urban 4 Lane Freeway	9.3%	11.5%
Urban or Rural 6 Lane Freeway	6.7%	12.9%
Urban > 6 Lane Freeway	12.6%	20.5%

\* Lower/upper limit of Average calculated as one standard deviation below/above the Mean

Similar Operating Environment	Crashes Involving Non-Motorized Travelers	
	Lower Limit of Average*	Upper Limit of Average*
2 or 3 Lane Undivided Highway	2.2%	4.2%
2 or 3 or 4 Lane Divided Highway	2.4%	4.5%
4 or 5 Lane Undivided Highway	4.7%	7.9%
6 Lane Highway	8.4%	17.4%
Rural 4 Lane Freeway with Daily Volume < 25,000	1.7%	2.5%
Rural 4 Lane Freeway with Daily Volume > 25,000	0.0%	0.0%
Urban 4 Lane Freeway	4.8%	10.3%
Urban or Rural 6 Lane Freeway	0.9%	6.7%
Urban > 6 Lane Freeway	0.5%	1.5%

\* Lower/upper limit of Average calculated as one standard deviation below/above the Mean

The crash unit types have the same “insufficient data” criteria as the SHSP behavior emphasis areas.

*Safety Hot Spots:* A hot spot analysis was conducted that identified abnormally high concentrations of fatal and incapacitating injury crashes along the study corridor by direction of travel. The identification of crash concentrations involves a GIS-based function known as “kernel density analysis”. This measure is mapped for graphical display purposes with the Directional Safety Index but is not included in the Safety performance area rating calculations.

### Freight Performance Area Calculation Methodologies

This section summarizes the approach for developing the primary and secondary performance measures in the Freight performance area as shown in the following graphic:



#### Primary Freight Index

The Freight Index is a reliability performance measure based on the planning time index for truck travel. The industry standard definition for the Truck Planning Time Index (TPTI) is the ratio of total travel time needed for 95% on-time arrival to free-flow travel time. The TPTI reflects the extra buffer time needed for on-time delivery while accounting for non-recurring delay. Non-recurring delay refers to unexpected or abnormal delay due to closures or restrictions resulting from circumstances such as crashes, inclement weather, and construction activities.

The TPTI can be converted into a speed-based index by recognizing that speed is equal to distance traveled divided by travel time. The inverse relationship between travel time and speed means that the 95<sup>th</sup> percentile highest travel time corresponds to the 5<sup>th</sup> percentile lowest speed. The speed-based TPTI is calculated using the following formula:

$$TPTI = \text{Free-Flow Truck Speed} / \text{Observed 5}^{th} \text{ Percentile Lowest Truck Speed}$$

Observed 5<sup>th</sup> percentile lowest truck speeds are available in the 2014 American Digital Cartography, Inc. HERE (formerly NAVTEQ) database to which ADOT has access. The free-flow truck speed is assumed to be 65 miles per hour or the posted speed, whichever is less. This upper limit of 65 mph

accounts for governors that trucks often have that restrict truck speeds to no more than 65 mph, even when the speed limit may be higher.

For each corridor segment, the TPTI is calculated for each direction of travel and then averaged to create a bi-directional TPTI. When assessing performance using TPTI, the higher the TPTI value is above 1.0, the more buffer time is needed to ensure on-time delivery.

The Freight Index is calculated using the following formula to invert the overall TPTI:

$$\text{Freight Index} = 1 / \text{Bi-directional TPTI}$$

Inversion of the TPTI allows the Freight Index to have a scale where the higher the value, the better the performance, which is similar to the directionality of the scales of most of the other primary measures. This Freight Index scale is based on inverted versions of TPTI scales created previously by ADOT. The scale for rating the Freight Index differs between uninterrupted and interrupted flow facilities.

#### Secondary Freight Measures

The Freight performance area includes five secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

- Recurring Delay (Directional TTTI)
- Non-Recurring Delay (Directional TPTI)
- Closure Duration
- Bridge Vertical Clearance
- Bridge Vertical Clearance Hot Spots

*Recurring Delay (Directional TTTI):* The performance measure for recurring delay is the Directional Truck Travel Time Index (TTTI). The industry standard definition for TTTI is the ratio of average peak period travel time to free-flow travel time. The TTTI reflects the extra time spent in traffic during peak times due to recurring delay. Recurring delay refers to expected or normal delay due to roadway capacity constraints or traffic control devices.

Similar to the TPTI, the TTTI can be converted into a speed-based index by recognizing that speed is equal to distance traveled divided by travel time. The speed-based TTTI can be calculated using the following formula:

$$TTTI = \text{Free-Flow Truck Speed} / \text{Observed Average Peak Period Truck Speed}$$

Observed average peak period truck speeds are available in the 2014 American Digital Cartography, Inc. HERE (formerly NAVTEQ) database to which ADOT has access. The free-flow truck speed is assumed to be 65 mph or the posted speed, whichever is less.



For each corridor segment, the TTTI is calculated for each direction of travel. With the TTTI, the higher the TTTI value is above 1.0, the more time is spent in traffic during peak times. TTTI values are generally lower than TPTI values. The Directional TTTI scale is based on TTTI scales created previously by ADOT.

**Non-Recurring Delay (Directional TPTI):** The performance measure for non-recurring delay is the Directional TPTI. Directional TPTI is calculated as described previously as an interim step in the development of the Freight Index.

For each corridor segment, the TPTI is calculated for each direction of travel. With the TPTI, the higher the TPTI value is above 1.0, the more buffer time is needed to ensure on-time delivery.

**Closure Duration:** This performance measure related to road closures is average roadway closure (i.e., full lane closure) duration time in minutes. There are three main components to full closures that affect reliability – frequency, duration, and extent. In the freight industry, closure duration is the most important component because trucks want to minimize travel time and delay.

Data on the frequency, duration, and extent of full roadway closures on the ADOT State Highway System is available for 2010-2014 in the HCRS database that is managed and updated by ADOT.

The average closure duration in a segment – in terms of the average time a milepost is closed per mile per year on a given segment – is calculated using the following formula:

$$\text{Closure Duration} = \text{Sum of Segment (Closure Clearance Time * Closure Extent)} / \text{Segment Length}$$

The segment closure duration time in minutes can then be compared to statewide averages for closure duration in minutes, with one-half standard deviation from the average forming the scale break points. The scale for rating closure duration in minutes is found at the end of this section.

**Bridge Vertical Clearance:** This performance measure uses the vertical clearance information from the ADOT Bridge Database to identify locations with low vertical clearance. The minimum vertical clearance for all underpass structures (i.e., structures under which mainline traffic passes) is determined for each segment.

**Bridge Vertical Clearance Hot Spots:** This performance measure related to truck restrictions is the locations, or hot spots, where bridge vertical clearance issues restrict truck travel. Sixteen feet three inches (16.25') is the minimum standard vertical clearance value for state highway bridges over travel lanes.

Locations with lower vertical clearance values than the minimum standard are categorized by the ADOT Intermodal Transportation Department Engineering Permits Section as either locations where ramps exist that allow the restriction to be avoided or locations where ramps do not exist and the restriction cannot be avoided. The locations with vertical clearances below the minimum standard that cannot be ramped around are considered hot spots. This measure is mapped for graphical display purposes with the bridge vertical clearance map but is not included in the Freight performance area rating calculations.

#### Scoring:

Performance Level	Freight Index	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	> 0.77	> 0.33
Fair	0.67 – 0.77	0.17 – 0.33
Poor	< 0.67	< 0.17

Performance Level	TTTI	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	< 1.15	< 1.30
Fair	1.15 – 1.33	1.30 – 2.00
Poor	> 1.33	> 2.00

Performance Level	TPTI	
	Uninterrupted Flow Facilities	Interrupted Flow Facilities
Good	< 1.30	< 3.00
Fair	1.30 – 1.50	3.00 – 6.00
Poor	> 1.50	> 6.00

Performance Level	Closure Duration (minutes)
Good	< 44.18
Fair	44.18 – 124.86
Poor	> 124.86

Performance Level	Bridge Vertical Clearance
Good	> 16.5'
Fair	16.0' – 16.5'
Poor	< 16.0'

## Appendix C: Performance Area Data

### Pavement Performance Area Data

				NB			SB			NB		SB		Composite		Pavement Index	% Pavement Failure	
				# of Lanes	IRI	Cracking	# of Lanes	IRI	Cracking	PSR	PDI	PSR	PDI	NB	SB		NB	SB
Segment 1		Interstate?		No														
Milepost	342	to	343	2	67.52	4.00		-	-	3.87	4.1	-	-	3.95	#NUM!		0	0
Milepost	343	to	344	2	67.52	9.00		-	-	3.87	3.5	-	-	3.63	#NUM!		0	0
Milepost	344	to	345	2	60.20	2.00		-	-	3.98	4.5	-	-	4.12	#NUM!		0	0
Milepost	345	to	346	2	60.48	3.00		-	-	3.97	4.3	-	-	4.07	#NUM!		0	0
Milepost	346	to	347	2	57.49	3.00		-	-	4.02	4.3	-	-	4.10	#NUM!		0	0
			Total	10			0											0
			Weighted Average							3.94	4.14	#DIV/0!	#DIV/0!	3.97	#NUM!			
			Factor							1.00		1.00						
			Indicator Score							3.94		#DIV/0!						0.0%
			Pavement Index													3.97		
Segment 2		Interstate?		No														
Milepost	347	to	348	4	61.87	3.00		-	-	3.95	4.3	-	-	4.05	#NUM!		0	0
Milepost	348	to	349	4	60.73	12.00		-	-	3.97	3.2	-	-	3.45	#NUM!		0	0
Milepost	349	to	350	4	69.64	9.00		-	-	3.84	3.5	-	-	3.62	#NUM!		0	0
Milepost	350	to	351	4	72.46	1.00		-	-	3.80	4.7	-	-	4.05	#NUM!		0	0
			Total	16			0											0
			Weighted Average							3.89	3.92	#DIV/0!	#DIV/0!	3.79	#NUM!			
			Factor							1.00		1.00						
			Indicator Score							3.89		#DIV/0!						0.0%
			Pavement Index													3.79		



				NB			SB			NB		SB		Composite		Pavement Index	% Pavement Failure	
				# of Lanes	IRI	Cracking	# of Lanes	IRI	Cracking	PSR	PDI	PSR	PDI	NB	SB		NB	SB
Segment 3		Interstate?		No														
Milepost	351	to	352	4	70.86	1.00		-	-	3.82	4.7	-	-	4.07	#NUM!		0	0
Milepost	352	to	353	2	64.96	0.00		-	-	3.91	5.0	-	-	4.23	#NUM!		0	0
Milepost	353	to	354	2	70.01	0.00		-	-	3.83	5.0	-	-	4.18	#NUM!		0	0
Milepost	354	to	355	2	69.15	0.00		-	-	3.84	5.0	-	-	4.19	#NUM!		0	0
Milepost	355	to	356	3	73.54	0.00		-	-	3.78	5.0	-	-	4.15	#NUM!		0	0
Milepost	356	to	357	3	60.86	0.00		-	-	3.97	5.0	-	-	4.28	#NUM!		0	0
Milepost	357	to	358	5	52.98	1.00		-	-	4.09	4.7	-	-	4.26	#NUM!		0	0
Milepost	358	to	359	5	99.73	0.00		-	-	3.42	5.0	-	-	3.90	#NUM!		0	0
Milepost	359	to	360	5	67.78	0.00		-	-	3.86	5.0	-	-	4.21	#NUM!		0	0
Milepost	360	to	361	5	101.68	0.00		-	-	3.40	5.0	-	-	3.88	#NUM!		0	0
Milepost	361	to	362	2	95.18	1.00		-	-	3.48	4.7	-	-	3.83	#NUM!		0	0
Milepost	362	to	363	3	88.05	4.00		-	-	3.58	4.1	-	-	3.75	#NUM!		0	0
Milepost	363	to	364	2	88.06	0.00		-	-	3.58	5.0	-	-	4.00	#NUM!		0	0
Milepost	364	to	365	2	91.89	2.00		-	-	3.53	4.5	-	-	3.80	#NUM!		0	0
		Total	45				0											0
		Weighted Average								3.72	4.83	#DIV/0!	#DIV/0!	4.06	#NUM!			
		Factor								1.00		1.00						
		Indicator Score								3.72		#DIV/0!					0.0%	
		Pavement Index														4.06		
Segment 4		Interstate?		No														
Milepost	365	to	366	3	50.72	2.00		-	-	4.12	4.5	-	-	4.22	#NUM!		0	0
Milepost	366	to	367	2	62.06	0.00		-	-	3.95	5.0	-	-	4.26	#NUM!		0	0
Milepost	367	to	368	2	72.34	15.00		-	-	3.80	2.9	-	-	3.20	#NUM!		0	0
Milepost	368	to	369	2	84.40	0.00		-	-	3.63	5.0	-	-	4.04	#NUM!		0	0
Milepost	369	to	370	2	49.09	4.00		-	-	4.15	4.1	-	-	4.14	#NUM!		0	0
Milepost	370	to	371	2	72.40	0.00		-	-	3.80	5.0	-	-	4.16	#NUM!		0	0
Milepost	371	to	372	2	93.57	10.00		-	-	3.50	3.4	-	-	3.45	#NUM!		0	0
Milepost	372	to	373	2	106.71	5.00		-	-	3.33	4.0	-	-	3.53	#NUM!		0	0
Milepost	373	to	374	2	79.40	1.00		-	-	3.70	4.7	-	-	3.98	#NUM!		0	0
Milepost	374	to	375	2	59.51	5.00		-	-	3.99	4.0	-	-	3.99	#NUM!		0	0
Milepost	375	to	376	2	56.19	5.00		-	-	4.04	4.0	-	-	4.01	#NUM!		0	0
Milepost	376	to	377	2	67.81	15.00		-	-	3.86	2.9	-	-	3.22	#NUM!		0	0
Milepost	377	to	378	2	58.34	2.00		-	-	4.01	4.5	-	-	4.14	#NUM!		0	0
Milepost	378	to	379	2	66.86	6.00		-	-	3.88	3.9	-	-	3.88	#NUM!		0	0
Milepost	379	to	380	2	79.04	2.00		-	-	3.70	4.5	-	-	3.93	#NUM!		0	0
Milepost	380	to	381	2	63.03	12.00		-	-	3.94	3.2	-	-	3.44	#NUM!		0	0
Milepost	381	to	382	2	57.77	5.00		-	-	4.01	4.0	-	-	4.01	#NUM!		0	0
Milepost	382	to	383	2	53.14	10.00		-	-	4.09	3.4	-	-	3.62	#NUM!		0	0
Milepost	383	to	384	2	65.64	9.00		-	-	3.90	3.5	-	-	3.64	#NUM!		0	0
Milepost	384	to	385	2	124.37	3.00		-	-	3.12	4.3	-	-	3.47	#NUM!		0	0
Milepost	385		386	2	99.36	2.00		-	-	3.43	4.5	-	-	3.74	#NUM!	0	0	
		Total	43				0										0	
		Weighted Average								3.81	4.07	#DIV/0!	#DIV/0!	3.82	#NUM!			
		Factor								1.00		1.00						
		Indicator Score								3.81		#DIV/0!					0.0%	
		Pavement Index														3.82		

### Bridge Performance Area Data

Structure Name (A209)			Structure # (N8)	Milepost (A232)	Area (A225)	Bridge Sufficiency	Bridge Index					Functionally Obsolete Bridges	Bridge Rating	Hot Spots on Bridge Index map	
						Sufficiency Rating	Deck (N58)	Sub (N59)	Super (N60)	Eval (N67)	Lowest	Deck Area on Func Obsolete			
Segment 1															
#N/A				#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A			
		Total			#N/A										
		Weighted Average				#N/A					#N/A	#N/A			
		Factor				1.00					1.00	1.00			
		Indicator Score				#N/A						#N/A	#N/A		
		Bridge Index									#N/A				
Segment 2															
#N/A				#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A			
		Total			#N/A										
		Weighted Average				#N/A					#N/A	#N/A			
		Factor				1.00					1.00	1.00			
		Indicator Score				#N/A						#N/A	#N/A		
		Bridge Index									#N/A				
Segment 3															
Cottonwood Wash Br			2430	361.80	16578	87.30	7.00	7.00	7.00	7.00	7.0	0			
		Total			16,578										
		Weighted Average				87.30					7.00	0.00%			
		Factor				1.00					1.00	1.00			
		Indicator Score				87.30						0.00%	7		
		Bridge Index									7.00				
Segment 4															
Five Mile Draw Br			20032	366.51	9268	90.60	8.00	8.00	8.00	8.00	8.0	0			
Seven Mile Draw Br			279	368.07	3631	58.80	6.00	6.00	6.00	6.00	6.0	3,631			
Bridge			280	370.78	2066	45.20	6.00	6.00	5.00	5.00	5.0	2,066			
Washboard Wash Br			198	379.26	3131	52.60	5.00	5.00	6.00	5.00	5.0	3,131			
		Total			18,096										
		Weighted Average				72.46					6.74	48.78%			
		Factor				1.00					1.00	1.00			
		Indicator Score				72.46						48.78%	5		
		Bridge Index									6.74				

Mobility Performance Area Data

Segment	Begin MP	End MP	Length (mi)	Facility Type	Flow Type	Terrain	No. of Lanes	Capacity Environment Type	Lane Width (feet)	Posted Speed Limit (mph)	Divided or Undivided	Access Points (per mile)	% No-Passing Zone	Street Parking
77-1	342	347	5	Rural	Uninterrupted	Rolling	2	Rural Two-Lane, Non-Signalized	12.00	58	Undivided	2.4	29%	N/A
77-2	347	351	4	Rural	Uninterrupted	Rolling	4	Multilane Highway	12.00	65	Undivided	1	0%	N/A
77-3	351	365	14	Rural	Interrupted	Rolling	2.6	Urban/Rural Single or Multilane Signalized	12.00	54	Undivided	N/A	33%	N/A
77-4	365	386	21	Rural	Uninterrupted	Level	2	Rural Two-Lane, Non-Signalized	12.00	65	Undivided	1.5	42%	N/A



Car TTI and PTI/Truck TTTI and TPTI – Northbound/Eastbound

Segment	TMC	timeperiod	week_type	ROAD_NUMBER	road_direction	cars_mean	trucks_mean	cars_P05	trucks_P05	Posted Speed limit	Assumed car free-flow speed	Assumed truck free-flow speed	Cars_PeakTTI	Trucks_PeakTTI	Cars_PeakPTI	Trucks_PeakPTI
77-1	115P06995	1 AM Peak	Weekday	AZ-77	Northbound	56.0	51.7	25.3	13.7	60	60	60	1.07	1.16	2.38	4.39
77-1	115P06995	2 Mid Day	Weekday	AZ-77	Northbound	56.8	54.2	29.2	21.8	60	60	60				
77-1	115P06995	3 PM Peak	Weekday	AZ-77	Northbound	58.8	54.2	35.4	18.6	60	60	60				
77-1	115P06995	4 Evening	Weekday	AZ-77	Northbound	58.2	53.3	29.8	18.0	60	60	60				
77-2	115P06995	1 AM Peak	Weekday	AZ-77	Northbound	56.0	51.7			65	65	65	1.16	1.26	No Data	No Data
77-2	115P06995	2 Mid Day	Weekday	AZ-77	Northbound	56.8	54.2			65	65	65				
77-2	115P06995	3 PM Peak	Weekday	AZ-77	Northbound	58.8	54.2			65	65	65				
77-2	115P06995	4 Evening	Weekday	AZ-77	Northbound	58.2	53.3			65	65	65				
77-2	115P06996	1 AM Peak	Weekday	AZ-77	Northbound	64.1	62.4	54.7	55.1	65	65	65	1.02	1.06	1.23	1.22
77-2	115P06996	2 Mid Day	Weekday	AZ-77	Northbound	63.8	62.2	52.8	54.5	65	65	65				
77-2	115P06996	3 PM Peak	Weekday	AZ-77	Northbound	64.7	62.6	55.8	55.8	65	65	65				
77-2	115P06996	4 Evening	Weekday	AZ-77	Northbound	64.9	61.5	55.4	53.2	65	65	65				
77-3	115P06996	1 AM Peak	Weekday	AZ-77	Northbound	64.1	62.4	54.7	55.1	65	65	65	1.02	1.06	1.23	1.22
77-3	115P06996	2 Mid Day	Weekday	AZ-77	Northbound	63.8	62.2	52.8	54.5	65	65	65				
77-3	115P06996	3 PM Peak	Weekday	AZ-77	Northbound	64.7	62.6	55.8	55.8	65	65	65				
77-3	115P06996	4 Evening	Weekday	AZ-77	Northbound	64.9	61.5	55.4	53.2	65	65	65				
77-3	115P06997	1 AM Peak	Weekday	AZ-77	Northbound	53.8	50.7	25.5	30.5	60	60	60	1.14	1.19	2.37	1.98
77-3	115P06997	2 Mid Day	Weekday	AZ-77	Northbound	53.0	51.6	26.1	30.5	60	60	60				
77-3	115P06997	3 PM Peak	Weekday	AZ-77	Northbound	54.7	52.5	31.7	32.9	60	60	60				
77-3	115P06997	4 Evening	Weekday	AZ-77	Northbound	54.1	51.5	29.2	32.9	60	60	60				
77-3	115P06998	1 AM Peak	Weekday	AZ-77	Northbound	32.6	29.1			36	36	36	1.12	1.23	No Data	No Data
77-3	115P06998	2 Mid Day	Weekday	AZ-77	Northbound	31.8	30.4	7.5	11.5	36	36	36				
77-3	115P06998	3 PM Peak	Weekday	AZ-77	Northbound	32.4	32.2	6.8	15.5	36	36	36				
77-3	115P06998	4 Evening	Weekday	AZ-77	Northbound	32.8	29.7	9.0	8.7	36	36	36				
77-3	115P06999	1 AM Peak	Weekday	AZ-77	Northbound	54.3	53.2	31.4	31.7	57	57	57	1.07	1.10	1.89	1.81
77-3	115P06999	2 Mid Day	Weekday	AZ-77	Northbound	53.4	52.4	30.3	32.9	57	57	57				
77-3	115P06999	3 PM Peak	Weekday	AZ-77	Northbound	54.3	52.9	34.8	31.7	57	57	57				
77-3	115P06999	4 Evening	Weekday	AZ-77	Northbound	54.5	52.2	34.8	34.8	57	57	57				
77-4	115P07000	1 AM Peak	Weekday	AZ-77	Northbound	67.0	60.9	60.6	39.2	65	65	65	1.00	1.07	1.12	1.66
77-4	115P07000	2 Mid Day	Weekday	AZ-77	Northbound	65.2	61.1	58.1	45.6	65	65	65				
77-4	115P07000	3 PM Peak	Weekday	AZ-77	Northbound	65.7	62.4	59.7	56.6	65	65	65				
77-4	115P07000	4 Evening	Weekday	AZ-77	Northbound	66.0	62.3	58.4	54.7	65	65	65				
77-4	115P07001	1 AM Peak	Weekday	AZ-77	Northbound	65.1	60.9	55.9	52.9	65	65	65	1.02	1.07	1.22	1.22
77-4	115P07001	2 Mid Day	Weekday	AZ-77	Northbound	63.3	60.6	54.1	52.9	65	65	65				
77-4	115P07001	3 PM Peak	Weekday	AZ-77	Northbound	63.2	60.5	52.9	53.6	65	65	65				
77-4	115P07001	4 Evening	Weekday	AZ-77	Northbound	64.0	60.4	54.1	52.9	65	65	65				

*Car TTI and PTI/Truck TTTI and TPTI – Southbound/Westbound*

Segment	TMC	timeperiod	week_type	ROAD_NUMBER	road_direction	cars_mean	trucks_mean	cars_P05	trucks_P05	Posted Speed limit	Assumed car free-flow speed	Assumed truck free-flow speed	Cars_PeakTTI	Trucks_PeakTTI	Cars_PeakPTI	Trucks_PeakPTI
77-1	115N05960	1 AM Peak	Weekday	AZ-77	Southbound	55.4	50.9	28.6	18.5	55	55	55	1.04	1.11	2.57	4.44
77-1	115N05960	2 Mid Day	Weekday	AZ-77	Southbound	53.3	50.2	21.4	13.7	55	55	55				
77-1	115N05960	3 PM Peak	Weekday	AZ-77	Southbound	55.1	49.7	26.4	12.4	55	55	55				
77-1	115N05960	4 Evening	Weekday	AZ-77	Southbound	54.9	50.0	26.7	16.8	55	55	55				
77-2	115N05960	1 AM Peak	Weekday	AZ-77	Southbound	55.4	50.9	28.6	18.5	65	65	65	1.22	1.31	3.03	5.23
77-2	115N05960	2 Mid Day	Weekday	AZ-77	Southbound	53.3	50.2	21.4	13.7	65	65	65				
77-2	115N05960	3 PM Peak	Weekday	AZ-77	Southbound	55.1	49.7	26.4	12.4	65	65	65				
77-2	115N05960	4 Evening	Weekday	AZ-77	Southbound	54.9	50.0	26.7	16.8	65	65	65				
77-2	115N06995	1 AM Peak	Weekday	AZ-77	Southbound	63.1	58.9	52.3	48.6	65	65	65	1.05	1.11	1.37	1.41
77-2	115N06995	2 Mid Day	Weekday	AZ-77	Southbound	61.9	58.4	47.5	46.1	65	65	65				
77-2	115N06995	3 PM Peak	Weekday	AZ-77	Southbound	63.0	59.1	51.5	47.9	65	65	65				
77-2	115N06995	4 Evening	Weekday	AZ-77	Southbound	62.4	58.4	49.1	47.9	65	65	65				
77-3	115N06999	1 AM Peak	Weekday	AZ-77	Southbound	64.9	61.3	58.3	53.5	65	65	65	1.00	1.06	1.15	1.22
77-3	115N06999	2 Mid Day	Weekday	AZ-77	Southbound	65.1	61.5	58.0	54.7	65	65	65				
77-3	115N06999	3 PM Peak	Weekday	AZ-77	Southbound	66.6	61.6	60.3	55.6	65	65	65				
77-3	115N06999	4 Evening	Weekday	AZ-77	Southbound	65.3	61.1	56.6	53.7	65	65	65				
77-3	115N06998	1 AM Peak	Weekday	AZ-77	Southbound	49.9	50.0	19.9	22.0	57	57	57	1.14	1.15	2.87	2.59
77-3	115N06998	2 Mid Day	Weekday	AZ-77	Southbound	50.1	49.4	23.3	22.4	57	57	57				
77-3	115N06998	3 PM Peak	Weekday	AZ-77	Southbound	51.8	51.0	28.0	23.6	57	57	57				
77-3	115N06998	4 Evening	Weekday	AZ-77	Southbound	52.7	50.5	30.4	26.7	57	57	57				
77-3	115N06997	1 AM Peak	Weekday	AZ-77	Southbound	31.9	30.8	10.6	15.5	36	36	36	1.13	1.27	No Data	No Data
77-3	115N06997	2 Mid Day	Weekday	AZ-77	Southbound	31.6	30.0	8.7	11.8	36	36	36				
77-3	115N06997	3 PM Peak	Weekday	AZ-77	Southbound	32.7	30.5	11.8	12.4	36	36	36				
77-3	115N06997	4 Evening	Weekday	AZ-77	Southbound	32.2	28.1			36	36	36				
77-3	115N06996	1 AM Peak	Weekday	AZ-77	Southbound	55.1	50.4	33.6	28.6	61	61	61	1.10	1.21	1.80	2.12
77-3	115N06996	2 Mid Day	Weekday	AZ-77	Southbound	54.9	51.0	33.6	33.6	61	61	61				
77-3	115N06996	3 PM Peak	Weekday	AZ-77	Southbound	55.3	52.0	33.6	34.8	61	61	61				
77-3	115N06996	4 Evening	Weekday	AZ-77	Southbound	54.8	50.2	33.6	33.6	61	61	61				
77-3	115N06995	1 AM Peak	Weekday	AZ-77	Southbound	63.1	58.9	52.3	48.6	65	65	65	1.05	1.11	1.37	1.41
77-3	115N06995	2 Mid Day	Weekday	AZ-77	Southbound	61.9	58.4	47.5	46.1	65	65	65				
77-3	115N06995	3 PM Peak	Weekday	AZ-77	Southbound	63.0	59.1	51.5	47.9	65	65	65				
77-3	115N06995	4 Evening	Weekday	AZ-77	Southbound	62.4	58.4	49.1	47.9	65	65	65				
77-4	115N06999	1 AM Peak	Weekday	AZ-77	Southbound	64.9	61.3	58.3	53.5	65	65	65	1.00	1.06	1.15	1.22
77-4	115N06999	2 Mid Day	Weekday	AZ-77	Southbound	65.1	61.5	58.0	54.7	65	65	65				
77-4	115N06999	3 PM Peak	Weekday	AZ-77	Southbound	66.6	61.6	60.3	55.6	65	65	65				
77-4	115N06999	4 Evening	Weekday	AZ-77	Southbound	65.3	61.1	56.6	53.7	65	65	65				
77-4	115N07000	1 AM Peak	Weekday	AZ-77	Southbound	62.1	58.4	50.3	49.7	65	65	65	1.04	1.12	1.29	1.46
77-4	115N07000	2 Mid Day	Weekday	AZ-77	Southbound	62.8	57.6	51.5	44.5	65	65	65				
77-4	115N07000	3 PM Peak	Weekday	AZ-77	Southbound	64.2	59.2	54.7	51.5	65	65	65				
77-4	115N07000	4 Evening	Weekday	AZ-77	Southbound	62.3	57.7	50.0	47.8	65	65	65				

Closure Data

Segment	Length (miles)	# of closures	Total miles of closures		Average Occurrences/Mile/Year	
			NB	SB	NB	SB
77-1	5	10	10.8	35.0	0.43	1.40
77-2	4	11	10.0	28.0	0.50	1.40
77-3	14	16	23.1	73.0	0.33	1.04
77-4	21	10	44.0	4.0	0.44	0.04



Segment	ITIS Category Description											
	Closures		Incidents/Accidents		Incidents/Crashes		Obstruction Hazards		Winds		Winter Storm Codes	
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
77-1	0	0	1	0	0	0	0	0	0	0	2	7
77-2	0	0	2	0	0	0	0	0	0	0	2	7
77-3	0	0	3	3	0	0	0	0	0	0	3	7
77-4	0	0	5	4	0	0	0	0	0	0	1	0

HPMS Data

SEGMENT	MP_FROM	MP_TO	WEIGHTED AVERAGE NB AADT	WEIGHTED AVERAGE SB AADT	WEIGHTED AVERAGE AADT	NB AADT	SB AADT	2015 AADT	K Factor	D-Factor	T-Factor
77-1	342	347	4086	4135	8221	4539	4493	9032	8	50	9
77-2	347	351	3926	3965	7891	4283	4268	8551	8	50	10
77-3	351	365	4017	4058	8075	4176	4166	8342	9	50	11
77-4	365	386	1543	1526	3068	1625	1579	3204	10	51	13

SEGMENT	Loc ID	BMP	EMP	Length	Pos Dir AADT	Neg Dir AADT	Corrected Pos Dir AADT	Corrected Neg Dir AADT	2015 AADT	K Factor	D-Factor	D-Factor Adjusted	T-Factor
77-1	100816	342.00	347.00	5.00	4539	4493	4539	4493	9032	8	53	50	9
77-2	100816	347.00	349.56	2.56	4539	4493	4539	4493	9032	8	53	50	9
	100817	353.37	357.41	4.04	4123	4257	4165	4165	8330	8	61	50	10
	102309	349.56	351.00	1.44	4139	4277	4158	4158	8316	8	57	50	10
77-3	100817	351.00	357.41	6.41	4123	4257	4165	4165	8330	8	61	50	10
	102309	349.56	353.37	3.81	4139	4277	4158	4158	8316	8	57	50	10
	100817	353.37	357.41	4.04	4123	4257	4165	4165	8330	8	61	50	10
	100818	357.41	357.87	0.46	5085	5020	5085	5020	10105	8	52	50	12
	100820	357.87	359.41	1.54	6863	6739	6863	6739	13602	8	52	50	9
	100822	359.41	361.05	1.64	6328	6323	6328	6323	12651	10	55	50	8
	100824	361.05	365.00	3.95	0	0	2176	2176	4352	10	54	50	14
77-4	100824	365.00	365.10	0.10	0	0	2176	2176	4352	10	54	50	14
	100825	365.10	386.00	20.90	1622	1576	1622	1576	3199	10	57	51	13



Bicycle Accommodation Data

Segment	BMP	EMP	Divided or Non	NB Right Shoulder Width	SB Right Shoulder Width	NB Left Shoulder Width	SB Left Shoulder Width	NB Effective Length of Shoulder	SB Effective Length of Shoulder	% Bicycle Accommodation
77-1	342	347	Undivided	7.8	7.8	N/A	N/A	4.9	4.9	97%
77-2	347	351	Undivided	4.2	4.2	N/A	N/A	0.5	0.5	13%
77-3	351	365	Undivided	4.4	3.9	N/A	N/A	5.8	4.3	36%
77-4	365	386	Undivided	2.5	2.3	N/A	N/A	0.0	0.0	0%

AZTDM Data

SEGMENT	Growth Rate	% Non-SOV
77-1	1.67%	12.9%
77-2	1.65%	13.6%
77-3	1.77%	16.9%
77-4	1.71%	14.5%

HERS Capacity Calculation Data

Segment	Capacity Environment Type	Facility Type	Terrain	Lane Width	NB Rt. Shoulder	SB Rt. Shoulder	F <sub>lw</sub> or f <sub>LS</sub>	NB F <sub>lc</sub>	SB F <sub>lc</sub>	Total Ramp Density	PHF	E <sub>T</sub>	f <sub>HV</sub>	f <sub>M</sub>	f <sub>A</sub>	g/C	f <sub>G</sub>	f <sub>NP</sub>	N <sub>m</sub>	f <sub>p</sub>	NB FFS	SB FFS	NB Peak-Hour Capacity	SB Peak-Hour Capacity	Major Direction Peak-Hour Capacity	Daily Capacity
77-1	4	Rural	Rolling	12.00	7.82	7.82	0.0	N/A	N/A	N/A	0.88	2	0.920	N/A	0.6	N/A	0.9	1.95	N/A	N/A	67.40	67.40	N/A	N/A	1195.02	22,762
77-2	2	Rural	Rolling	12.00	4.22	4.22	0.0	0.9	0.4	N/A	0.88	2.5	0.875	1.6	0.25	N/A	N/A	N/A	N/A	N/A	62.25	62.75	3388	3388	N/A	64,538
77-3	3	Rural	Rolling	12.00	4.42	3.86	1.0	N/A	N/A	N/A	0.9	2	0.905	N/A	N/A	0.55	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1111.12	21,164
77-4	4	Rural	Level	12.00	2.46	2.33	2.6	N/A	N/A	N/A	0.88	1.5	0.939	N/A	0.37	N/A	1	3.30	N/A	N/A	72.03	72.03	N/A	N/A	1528.90	29,122



Safety Performance Area Data

Segment	Operating Environment	Segment Length (miles)	NB Fatal Crashes 2011-2015	SB Fatal Crashes 2011-2015	NB Incapacitating Injury Crashes	SB Incapacitating Injury Crashes	Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors
77-1	2 or 3 Lane Undivided Highway	5.28	5	1	0	0	0
77-2	4 or 5 Lane Undivided Highway	8.73	4	2	0	3	0
77-3	4 or 5 Lane Undivided Highway	21.61	14	1	1	3	0
77-4	2 or 3 Lane Undivided Highway	22.02	21	0	1	1	3

Segment	Operating Environment	Fatal + Incapacitating Injury Crashes Involving Trucks	Fatal + Incapacitating Injury Crashes Involving Motorcycles	Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Weighted 5-Year (2011-2015) Average NB AADT	Weighted 5-Year (2011-2015) Average SB AADT	Weighted 5-Year (2011-2015) Average Total AADT
77-1	2 or 3 Lane Undivided Highway	0	0	0	4086	4135	8221
77-2	4 or 5 Lane Undivided Highway	0	0	0	3561	3593	7154
77-3	4 or 5 Lane Undivided Highway	0	0	1	3664	3697	7361
77-4	2 or 3 Lane Undivided Highway	0	0	0	1728	1722	3450

HPMS Data

2011-2015 Weighted Average						2015			2014			2013			2012			2011		
SEGMENT	MP_FROM	MP_TO	WEIGHTED AVERAGE NB AADT	WEIGHTED AVERAGE SB AADT	WEIGHTED AVERAGE AADT	NB AADT	SB AADT	2015 AADT	NB AADT	SB AADT	2014 AADT	NB AADT	SB AADT	2013 AADT	NB AADT	SB AADT	2012 AADT	NB AADT	SB AADT	2011 AADT
77-1	342	347	4086	4135	8221	4539	4493	9032	3961	4049	8010	4094	4223	8317	3960	4035	7995	3877	3877	7753
77-2	347	351	3926	3965	7891	4283	4268	8551	3862	3922	7784	3989	4095	8084	3750	3789	7539	3748	3748	7497
77-3	351	365	4017	4058	8075	4176	4166	8342	3899	3974	7874	4173	4200	8374	3779	3894	7673	4056	4056	8112
77-4	365	386	1543	1526	3068	1625	1579	3204	1564	1525	3089	1533	1533	3065	1370	1370	2739	1622	1622	3244



Freight Performance Area Data

Segment	Length (miles)	# of closures	Total minutes of closures		Avg Mins/Mile/Year	
			NB	SB	NB	SB
77-1	5	10	14366.2	29100.0	574.65	1164.00
77-2	4	11	12162.0	23280.0	608.10	1164.00
77-3	14	16	35222.4	58723.0	503.18	838.90
77-4	21	10	8480.0	651.0	84.80	6.51

Segment	ITIS Category Description											
	Closures		Incidents/Accidents		Incidents/Crashes		Obstruction Hazards		Winds		Winter Storm Codes	
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
77-1	0	0	1	0	0	0	0	0	0	0	2	7
77-2	0	0	2	0	0	0	0	0	0	0	2	7
77-3	0	0	3	3	0	0	0	0	0	0	3	7
77-4	0	0	5	4	0	0	0	0	0	0	1	0

See the **Mobility Performance Area Data** section for other Freight Performance Area related data.

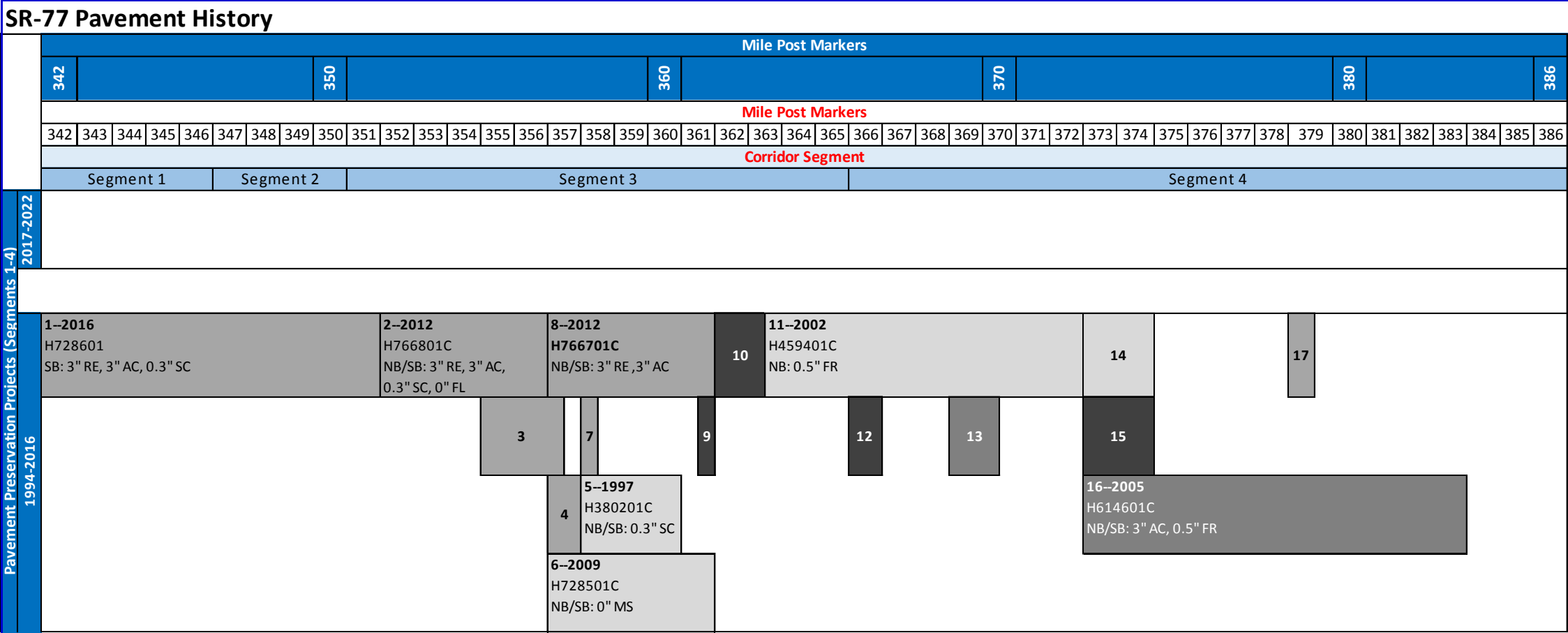
## **Appendix D: Needs Analysis Contributing Factors and Scores**



### Pavement Performance Needs Analysis

Segment	Segment Length (miles)	Segment Mileposts (MP)	Final Need	Bid History Investment	PeCos History Investment	Resulting Historical Investment	Contributing Factors and Comments
77-1	5	342-347	None	Low	Low	Low	No need identified
77-2	4	347-351	None	Low	Low	Low	No need identified
77-3	14	351-365	None	Low	Low	Low	No need identified
77-4	21	365-386	None	Low	Low	Low	No need identified

Pavement History



Pavement Treatment Reference Numbers	Pavement Treatment Reference Numbers
1. 2016 (NB/SB) H728601C: Remove 3", New 3" AC, 0.3" SC	10. 2002 (NB) H459401C: 8" AB, 4" AC, 0.5" FR
2. 2012 (NB/SB) H766801C: Remove 3", New 3" AC, 0.3" SC, 0" FL	11. 2002 (NB/SB) H459401C: 0.5" FR
3. 2007 (NB/SB) H723201C: Remove 3", New 3" AC	12. 2015 (NB/SB) H728601C: (MP 366.16-366.25) Remove 0.5", New 0.5" FC (MP 366.25-366.9) 10" AB, 5" AC, 0.5" FC (NB) (MP 366.25-366.55) 10" AB, 5" AC, 0.5" FC (SB) (MP 366.25-366.77) Remove 0.5", New 0.5" FC
4. 1997 (NB/SB) H380201C: Remove 1.5", New 1.5" AC, 0.3" SC	13. 2011 (NB/SB) H546001C: 2" AC, 0.5" FC
5. 1997 (NB/SB) H380201C: 0.3" SC	14. 1999 (NB/SB) H432301C: 0.6" DC
6. 2009 (NB/SB) H728501C: 0" MS	15. 1999 (SB) H432301C: 6" AB, 4" AC, 0.6" DC
7. 2007 (NB/SB) H704601C: Remove 3", New 3" AC, 0" FL	16. 2005 (NB/SB) H614601C: 3" AC, 0.5" FR
8. 2012 (NB/SB) H766701C: Remove 3", New 3" AC	17. 2010 (NB/SB) H792301C: (MP 379.27-379.35) Remove 4.5", New 4.5" AC, 0"FL
9. 1994 (NB/SB) H320601C: (MP 361.44-361.61) 0" GT, 4" AB, 9" AC, 0" FL (MP 361.61-361.75) 4" AB, 9" AC, 0" FL (MP 361.81-361.95) 4" AB, 9" AC, 0" FL	

Legend

New Paving or Reconstruction

Mill and Overlay (Adding Structural Thickness)

Mill and Replace (No Change Structural Thickness)

Fog Coat or Thin Overlay Treatments

PCCP Pavement Border

AC Pavement Border

Value	Level	Segment Number							
		1		2		3		4	
		Uni-Dir	Bi-Dir	Uni-Dir	Bi-Dir	Uni-Dir	Bi-Dir	Uni-Dir	Bi-Dir
1	L1						20%		10%
1							17%		33%
1							33%		
1									
1									
3	L2		100%		100%		7%		2%
3							33%		
3							33%		
3							17%		
3							7%		
3							3%		
4	L3								52%
4									7%
4									
4									
4									
6	L4						3%	10%	5%
6						10%			
6									
6									
6									
6									
Sub-Total		0.0	3.0	0.0	3.0	0.6	3.9	0.6	3.2
Total		3.0		3.0		4.2		3.5	



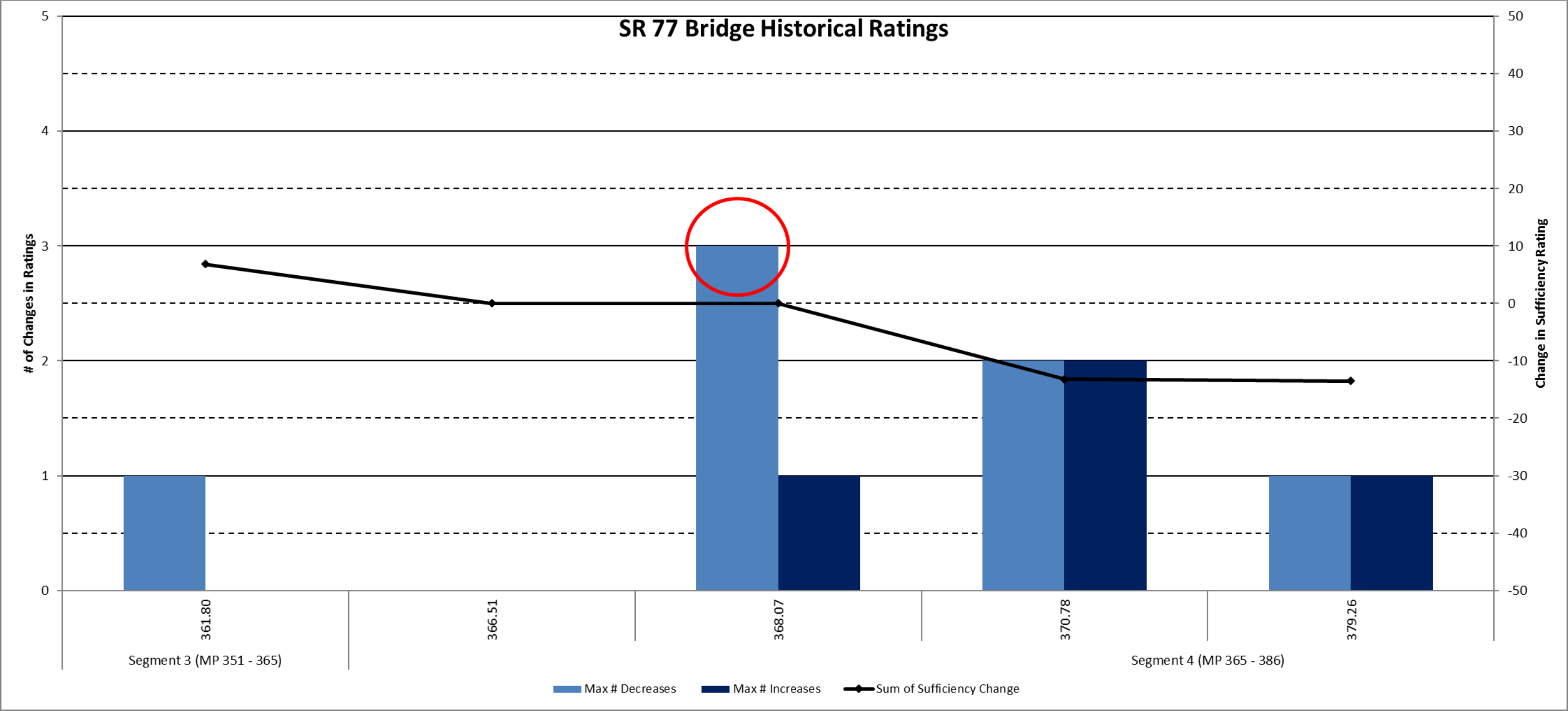
### Pavement Historical Investment

Segment	Pavement History Value (bid projects)	Pavement History Score (bid projects)	Pavement History (bid projects)	PeCos (\$/mile/yr)	PeCos Score	PeCos	Resulting Historical Investment
77-1	3.00	-0.56	Low	\$157.76	-0.21	Low	Low
77-2	3.00	-1.59	Low	\$119.57	10.04	Low	Low
77-3	4.20	-1.11	Low	\$212.78	1.64	Low	Low
77-4	3.50	-0.20	Low	\$677.35	0.11	Low	Low

### Bridge Performance Needs Analysis

Segment	Segment Length (Miles)	Segment Mileposts (MP)	Number of Bridges in Segment	# Functionally Obsolete Bridges	Final Need	Contributing Factors			Comments
						Bridge	Current Ratings	Historical Review	
77-1	5	342-347	0	None	None	No bridges in segment			
77-2	4	347-351	0	None	None	No bridges in segment			
77-3	14	351-365	1	None	None	No bridges with current ratings less than 6 and no historical issues			
77-4	21	365-386	4	3	Low	Seven Mile Draw Br (#279)(MP 368.07)  Bridge (#280)(MP 370.78)  Washboard Bridge (#198)(MP 379.26)	N/A  2015 Current Superstructure Rating of 5 2015 Current Structure Evaluation of 5  2015 Current Deck Rating of 5 2015 Current Substructure Rating of 5 2015 Current Strucutre Evaluation of 5	Could have a repetitive investment issue  N/A  N/A	Bridge Infrastructure Improvements with immediate needs between Holbrook and Snowflake (Arizona Key Commerce Corridors, MP 365-385)

Bridge Ratings History



identifies the bridge indicated is of concern from a historical ratings perspective

Maximum # of Decreases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating decreased from 1997 to 2014. (Higher number could indicate a more dramatic decline in the performance of the bridge)

Maximum # of Increases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating increased from 1997 to 2014. (Higher number could indicate a higher level of investment)

Change in Sufficiency Rating: Cumulative change in Sufficiency Rating from 1997 to 2014. (Bigger negative number could indicate a more dramatic decline in the performance of the bridge)

Mobility Performance Needs Analysis

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Roadway Variables								Traffic Variables						Relevant Mobility Related Existing Infrastructure
				Functional Classification	Environmental Type (Urban/Rural)	Terrain	# of Lanes/ Direction	Weighted Average Speed Limit	Aux Lanes	Divided/ Non-Divided	% No Passing	Existing LOS	Future 2035 LOS	% Trucks	NB Buffer Index (PTI-TTI)	SB Buffer Index (PTI-TTI)		
77-1	342-347	5	Low	State Highway	Rural	Rolling	2	58	No	Non-Divided	50%	A/B	C	9%	1.30	1.54		
77-2	347-351	4	Low	State Highway	Rural	Rolling	4	65	No	Non-Divided	0%	A/B	A/B	9%	0.14	1.06		
77-3	351-365	14	Low	State Highway	Rural	Rolling	4	54	No	Non-Divided	5%	A/B	A/B	11%	0.74	0.71		
77-4	365-386	21	Low	State Highway	Rural	Level	2	65	No	Non-Divided	50%	A/B	A/B	14%	0.16	0.20	RWIS NB/SB MP 375.5	



## Mobility Performance Needs Analysis (continued)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/Accidents	% Incidents/Accidents	# Obstructions/Hazards	% Obstructions/Hazards	# Weather Related	% Weather Related			
77-1	342-347	5	Low	10	1	10%	0	0%	9	90%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (MP 343.3-349.6) with wildlife crossing overpass/underpass at MP 347. (BQAZ, SR 77: Show Low to Taylor – DCR [MP 342.2 – MP 357.4])</p> <p>New TI: US 60 at SR 77 and SR 77 at Silver Lake Blvd (Traffic Impact Statement for the Intersection of US 60 and SR 77: Show Low to Little Mormon Lake, MP 342.2)</p>	<ul style="list-style-type: none"> <li>- High percentage of closures due to weather conditions, with the majority in the SB direction.</li> <li>- Four long duration (over 1000 minute) closures.</li> <li>- Low number of closures were due to incidents.</li> </ul>
77-2	347-351	4	Low	11	2	18%	0	0%	9	82%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (MP 343.3-349.6) with wildlife crossing overpass/underpass at MP 347. (BQAZ, SR 77: Show Low to Taylor – DCR [MP 342.2 – MP 357.4])</p> <p>Grade Separated Intersection at SR 77 and White Mountain Lake Road (MP 349.5) (Southern Navajo/Apache County Sub Regional Transportation Plan)</p>	<ul style="list-style-type: none"> <li>- High percentage of closures due to weather conditions, mostly in the SB direction.</li> <li>- Low number of closures were due to incidents.</li> <li>- Four long duration (over 1000 minutes) closures</li> <li>- Low level of bicycle accommodations.</li> </ul>
77-3	351-365	14	Low	16	6	38%	0	0%	10	63%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (MP 351.5-352.1 and MP 353.0-353.7) with wildlife crossing overpass/underpass at MP 351-352 and MP 345.4. (BQAZ, SR 77: Show Low to Taylor –DCR [MP 342.2 – MP 357.4])</p>	<ul style="list-style-type: none"> <li>- High percentage of closures due to weather conditions, with the majority in the SB direction from MP 351 to 361.</li> <li>- Low number of closures were due to incidents.</li> <li>- Five very long duration closures (four over 1000 minutes, one over 8000 minutes)</li> <li>- Low level of bicycle accommodations.</li> </ul>

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/ Accidents	% Incidents/ Accidents	# Obstructions/ Hazards	% Obstructions/ Hazards	# Weather Related	% Weather Related			
77-4	365-386	21	Low	10	9	90%	0	0%	1	10%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (NB/SB: MP 365.20-MP 366.50 and MP 369.10-MP 370.60). (BQAZ)</p> <p>Proposed NB DMS (Arizona Statewide Dynamic Message Master Plan, MP 380)</p>	<p>- High percentage of closures due to incidents/accidents, with the majority in the NB direction.</p> <p>-Low level of bicycle accommodations.</p>

Safety Performance Needs Analysis

Segment Number		77-1	77-2	77-3	77-4	Corridor-Wide Crash Characteristics
Segment Length (miles)		5	4	14	21	
Segment Milepost (MP)		342 - 347	347 - 351	351 - 365	365 - 386	
Final Need		Medium	High	None	Low	
Segment Crash Overview		1 Crashes were fatal 0 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	2 Crashes were fatal 3 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	2 Crashes were fatal 3 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	1 Crashes were fatal 4 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	6 Crashes were fatal 10 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles
Segment Crash Summaries (Fatal and Serious Injury Crashes)	First Harmful Event Type	N/A - Sample Size Too Small	40% Involve Collision with Motor Vehicle 40% Other Non-Collision 20% Involve Overturning	80% Involve Collision with Motor Vehicle 20% Involve Collision with Pedestrian	60% Involve Overturning 40% Involve Collision with Motor Vehicle	50% Involve Collision with Motor Vehicle 25% Involve Overturning 13% Involve Other Non-Collision
	Collision Type	N/A - Sample Size Too Small	60% Involve Single Vehicle 20% Involve Angle 20% Other	60% Involve Angle 20% Involve Head On 20% Other	60% Involve Single Vehicle 20% Involve Rear End 20% Head On	44% Involve Single Vehicle 25% Involve Angle 13% Involve Head On
	Violation or Behavior	N/A - Sample Size Too Small	20% Involve Speed too Fast for Conditions 20% Failure to Keep in Proper Lane 20% Drove in Opposing Lane	60% Involve Failure to Yield Right-of-Way 20% Involve Other 20% Unknown	60% Involve Speed too Fast for Conditions 20% Involve Drove in Opposing Lane 20% Failure to Keep in Proper Lane	25% Involve Speed too Fast for Conditions 25% Involve Speed too Fast for Conditions 13% Involve Drove in Opposing Lane
	Lighting Conditions	N/A - Sample Size Too Small	60% Occur in Daylight Conditions 40% Occur in Dark-Unlighted Conditions	80% Occur in Daylight Conditions 20% Occur in Dark-Unknown Lighting Conditions	60% Occur in Daylight Conditions 20% Occur in Dawn Conditions 20% Occur in Dark-Unlighted Conditions	63% Occur in Daylight Conditions 19% Occur in Dark-Unlighted Conditions 6% Occur in Dawn Conditions
	Surface Conditions	N/A - Sample Size Too Small	80% Involve Dry Conditions 20% Involve Slush Conditions	80% Involve Dry Conditions 20% Involve Unknown Conditions	100% Involve Dry Conditions	88% Involve Dry Conditions 6% Involve Slush Conditions 6% Involve Slush Conditions
	First Unit Event	N/A - Sample Size Too Small	40% Involve a first unit event of Ran Off the Road (Right) 40% Involve Crossing the Centerline 20% Involve a first unit event of Motor Vehicle in Transport	80% Involve a first unit event of Motor Vehicle in Transport 20% Involve a first unit event of Crossed Centerline	60% Involve a first unit event of Ran Off the Road (Right) 20% Involve a first unit event of Crossed Centerline 20% Involve Motor Vehicle in Transport	38% Involve a first unit event of Ran Off the Road (Right) 38% Involve a first unit event of Ran Off the Road (Right) 25% Involve a first unit event of Crossed Centerline
	Driver Physical Condition	N/A - Sample Size Too Small	80% Under the Influence of Drugs or Alcohol 20% No Apparent Influence	60% No Apparent Influence 20% Under the Influence of Drugs or Alcohol 20% Unknown	60% No Apparent Influence 20% Fatigued/Fell Asleep 20% Unknown	44% No Apparent Influence 31% Under the Influence of Drugs or Alcohol 19% Unknown
	Safety Device Usage	N/A - Sample Size Too Small	80% None Used 20% Air Bag Deployed/Shoulder-Lap Belt	40% Shoulder And Lap Belt Used 20% Air Bag Deployed/Shoulder-Lap Belt 20% None Used	40% Shoulder And Lap Belt Used 40% None Used 20% Air Bag Deployed	44% None Used 31% Shoulder And Lap Belt Used 13% Air Bag Deployed/Shoulder-Lap Belt
Hot Spot Crash Summaries						
Previously Completed Safety-Related Projects						
District Interviews/Discussions						
Contributing Factors						

### Freight Performance Needs Analysis

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Roadway Variables								Traffic Variables					Relevant Freight Related Existing Infrastructure
				Functional Classification	Environmental Type (Urban/Rural)	Terrain	# of Lanes/ Direction	Weighted Average Speed Limit	Aux Lanes	Divided/ Non-Divided	% No Passing	Existing LOS	Future 2035 LOS	% Trucks	NB/EB Buffer Index (TPTI-TTTI)	SB/WB Buffer Index (TPTI-TTTI)	
77-1	342-347	5	High	State Highway	Rural	Rolling	2	58	No	Non-Divided	50%	A/B	A-C	9%	3.23	3.33	
77-2	347-351	4	High	State Highway	Rural	Rolling	4	65	No	Non-Divided	0%	A/B	A/B	9%	0.07	2.11	
77-3	351-365	14	Low	State Highway	Rural	Rolling	4	54	No	Non-Divided	5%	A/B	A/B	11%	0.53	0.67	
77-4	365-386	21	Low	State Highway	Rural	Level	2	65	No	Non-Divided	50%	A/B	A/B	14%	0.37	0.24	RWIS NB/SB MP 375.5



### Freight Performance Needs Analysis (continued)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Final Need	Closure Extent							Non-Actionable Conditions	Programmed and Planned Projects or Issues from Previous Documents Relevant to Final Need	Contributing Factors
				Total Number of Closures	# Incidents/Accidents	% Incidents/Accidents	# Obstructions/Hazards	% Obstructions/Hazards	# Weather Related	% Weather Related			
77-1	342-347	5	High	10	1	10%	0	0%	9	90%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (MP 343.3-349.6) with wildlife crossing overpass/underpass at MP 347. (BQAZ, SR 77: Show Low to Taylor – DCR (MP 342.2 – MP 357.4))</p> <p>New TI: US 60 at SR 77 and SR 77 at Silver Lake Blvd (Traffic Impact Statement for the Intersection of US 60 and SR 77: Show Low to Little Mormon Lake, MP 342.2)</p>	<ul style="list-style-type: none"> <li>- High percentage of closures due to weather conditions, with the majority in the SB direction.</li> <li>- Four long duration (over 1000 minute) closures.</li> <li>- Low number of closures were due to incidents.</li> <li>- Trucks stopping at Maverick gas station (MP 342.2) Q39</li> </ul>
77-2	347-351	4	High	11	2	18%	0	0%	9	82%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (MP 343.3-349.6) with wildlife crossing overpass/underpass at MP 347. (BQAZ, SR 77: Show Low to Taylor – DCR (MP 342.2 – MP 357.4))</p> <p>Grade Separated Intersection at SR 77 and White Mountain Lake Road (MP 349.5) (Southern Navajo/Apache County Sub Regional Transportation Plan)</p>	<ul style="list-style-type: none"> <li>- High percentage of closures due to weather conditions, mostly in the SB direction.</li> <li>- Low number of closures were due to incidents.</li> <li>- Four long duration (over 1000 minutes) closures</li> <li>- Low number of closures were due to incidents.</li> <li>- Trucks entering and exiting corridor at MP 349.28 for access to Refuse Transfer Station may be affecting TPTI measurements and scores.</li> </ul>
77-3	351-365	14	Low	16	6	38%	0	0%	10	63%		<p>Programmed: None</p> <p>Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (MP 351.5-352.1 and</p>	<ul style="list-style-type: none"> <li>- High percentage of closures due to weather conditions, with the majority in the SB direction from MP 351 to 361.</li> <li>- Low number of closures were due to incidents.</li> </ul>

												MP 353.0-353.7) with wildlife crossing overpass/underpass at MP 351-352 and MP 345.4. (BQAZ, SR 77: Show Low to Taylor –DCR (MP 342.2 – MP 357.4))	- Five very long duration closures (four over 1000 minutes, one over 8000 minutes)
77-4	365-386	21	Low	10	9	90%	0	0%	1	10%		Programmed: None  Planned: SR 77 roadway widening: 4-lanes Show Low to Holbrook (NB/SB: MP 365.20-MP 366.50 and MP 369.10-MP 370.60). (BQAZ)  Proposed NB DMS (Arizona Statewide Dynamic Message Master Plan, MP 380)	- High percentage of closures due to incidents/accidents, with the majority in the NB direction. - Large-haul trucks traveling between Snowflake and Holbrook for access to Refuse Transfer Station (MP 342.28) and Brimhall Quarry (MP 361.37) may be affecting TPTI measurements and scores.

Needs Summary Table

Performance Area	77-1	77-2	77-3	77-4
	MP 342-347	MP 347-351	MP 351-365	MP 365-386
Pavement+	None*	None*	None*	None*
Bridge	None*	None*	None*	Low
Mobility+	Low	Low	Low	Low
Safety+	Medium	High	None*	Low
Freight	High	High	Low	Low
Average Need	1.15	1.38	0.38	0.77

\* Identified as an emphasis area for the SR 77  
 \* A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study

Level of Need	Average Need Range
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0